THE

ELECTRICAL REVIEW.

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ELECTRICAL REVIEW.

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ELECTRICITY ON THE RAND.

ON previous occasions we have printed full accounts of the extraordinary development of electricity supply on the Witwatersrand—respectively from the point of view of the supply company, as represented by Mr. A. E. Hadley (ELEC. REV., March 28th, 1913), and from that of the consumer, in the person of Mr. J. H. Rider (ELEC. REV., April 23rd to May 21st, 1915).

The presidential address delivered by Mr. Bernard Price to the South African Institute of Electrical Engineers, of which we publish an abstract in this issue, forms a fitting pendant to these articles, providing a comparison between the undertaking and other great schemes, and a general review of the whole system.

The undertaking, as a whole, presents many unique and interesting features: it is one of the largest of its kind in the world, and has been carried out on independent lines, conforming to the special local circumstances rather than to the established practice of other installations; the pressure of transmission from the main station is very high (80,000 volts), and the distributing pressure is also unusually high (20,000 volts, a pressure which in this country has not yet been exceeded in the main transmission lines); no less than 99 per cent. of the supply is consumed by the mining industry, a feature which is hardly paralleled except in the case of large hydro-electric schemes carried out for specific industrial processes; and the output is gigantic—four times the whole consumption of Manchester. The load factor, too, is extraordinarily high, and it will be noticed that even during the last three years the load has practically doubled. The enormous supply of compressed air to the mines represents an entirely unique departure; nowhere else is such a system to be found on the grand scale here met with.

The possibility of using the overload capacity of the plant to deal with peaks of short duration, of which Mr. Price had experience on Tyneside, is here utilised to great advantage; as he points out, the heat capacity of the machines and transformers is so great that the temperature on overload rises but slowly, and the boilers and turbines are well adapted to deal with temporary overloads, so that plant rated at the average load can deal with all ordinary fluctuations, and its efficiency can be maintained at a high level. Mr. Price states that these advantages increase in value with the size of the plant.

Another remarkable feature of the system is the large number of electric winders connected, a class of demand which is not usually regarded as very desirable, owing to the extreme variations of load; but Mr. Price holds that once a few winders have been connected, the more added the better. Probably there is no other district in the world where so many main electric winders are energised by a single undertaking, and in the light of this development it is interesting to recall the

detailed and pessimistic comparisons between steam and electric winding that were made in this country some ten years ago; there are always to be found amongst us people who declare that "it can't be done," whenever any new proposition is brought forward, and though they may be confounded by the event, they bob up again somewhere else with undiminished scepticism. We have seen this attitude adopted with regard to main-line electrification, power supply from large central stations, the electric driving of textile mills, and, more recently, to the electric vehicle, electric cooking and heating, electricity supply at ½d. per unit, &c. Nevertheless, as in the case of electric winding, these things generally do come to pass in the long run, and sometimes very quickly. The prophet of failure has a thankless task, and indeed exerts a detrimental influence upon the community.

It is somewhat singular that the load factor of the Rand supply is so high, in spite of the fact that in this case so little benefit is apparently derived from diversity of demand; but probably the method adopted for determining the diversity factor from smoothed curves, instead of instantaneous maximum demands, masks the diversity to a great extent. The question naturally arises: what would be the effect of undertaking other classes of supply, in addition to the mining industry? As Mr. Price points out, the present load curve possesses a peak of long duration which would not overlap the peaks on the curves of a city supply for lighting and traction, and, therefore, the addition of such a load would improve the load factor. Carrying the process further, Mr. Price is led to endorse the view of Dr. Ferranti, that if electricity were employed for all possible purposes an enormous saving in capital and fuel would result. It will be noted that in Chicago the week-day load-factor is already 56 per cent. Such a result can only be attained by the co-operation or concentration of all sources of supply in a district under a single management.

Many other lessons may be derived from a study of Mr. Price's interesting address, which revives our hopes that we may yet see electricity supplied for all purposes at a rate approaching ½d. per unit. As a speculation, let us suppose that, owing to increased economy of working and improvements in plant, the cost of generation on the large scale could be halved every time the output was doubled; in that case we should reach the goal when the output was about 16 times the present value.

Copper.

The copper market has had a reactionary tendency in spite of fitful gleams of firmness. There can be little doubt that fundamental conditions are being affected by the growing production, which is particularly manifest in the United States, though it must not be overlooked at the same time that output is rapidly increasing in other parts of the world, more especially Africa and South America, where some very big properties have recently come into effective operation, and are shipping raw copper both to Europe and to the United States. The attitude of the leading producers continues to be one of passive resistance to the less favourable market tendencies observable, and so far as Europe is concerned they have, for weeks past, been practically out of the market, but in America they seem now more responsive to bids. As to Europe, they apparently assumed that their position was so unassailable that they could afford to play ducks and drakes with consumers by declining to make quotations on the basis hitherto obtaining, namely, of sterling prices per ton on c.i.f. terms, quoting instead in cents per lb. f.o.b. America. The natural consequence of this has been, of course, that people in Europe have stood aside; consumers, rendered cautious by the excessively high prices ruling, and taught by experience that the American attitude has always been to drive up quotations wherever possible, have abstained from buying, and business has accordingly been limited to very small proportions. There was a sharp rise just after the holidays, the movement causing some searching of hearts, because circumstances outwardly, at all events, do not appear to justify the increased confidence. It was stated that things had taken a better turn again in America, but this really seems hardly possible, and the actual explanation of the fitful rise was that the Government had permitted several hundred tons of rough copper to be shipped from here to America, where it is to be turned into electrolytic metal, and reshipped to England. The Government have, by this measure, undoubtedly managed to secure a supply of cheap metal, and they have at the same time rendered standard copper a marketable commodity, which it had ceased to be, in consequence of the export prohibitions. Any movement which tends to increase the output of refined copper is good, and it is a matter for hearty congratulation that, at the eleventh hour, there seem to be indications of a little common-sense in one of our Government departments concerned with trade, a quality conspicuously absent during the past 12 months. The statistical position in Europe is not much to boast about, and the possibilities are that there will be a further increase in available stocks as time goes on. Consumption is almost limited now to the provision of war munitions, and business of a general merchant character is actively discouraged by the authorities. So long as war munitions can be turned out on an ever-increasing scale, the consumption of copper is bound to expand, but it is exceedingly doubtful whether, under any circumstances, war consumption can equal the demands of peace. If it cannot, and does not, then refined copper at the present rate of output is still pounds too high. This aspect of the position is beginning to attract some attention in the United States, and accounts for the fact that producers are showing impatience for another buying movement to develop. Generally they are, no doubt, well sold, but this is by no means the universal position of affairs, and, indeed, one of the largest interests is said to be wanting business for almost immediate delivery. No doubt a further buying movement is due soon, and no doubt also the utmost will be made of it, if and when it does appear; but the war position is so exceedingly disappointing, and financial conditions need such careful watching, that a continuance of high prices for such a commodity as copper seems to be out of the question, especially as output is becoming colossal.

Electrical Pyrometry.

The difficulties met with in the determination of high temperatures under workshop conditions were formerly very great, and undoubtedly the lack of means of accurate measurement in this respect greatly retarded the scientific development of many industries, such as metallurgy and pottery; the use of small fusible cones composed of various substances, with melting-points that were approximately known, afforded a fairly close estimate of the temperature, but in many cases the skill acquired by the workmen during long years was relied upon to determine the temperature by eye, and the degree of expertness to which some of these men attained was truly marvellous. It is, however, extremely unsatisfactory to have to depend upon a human thermometer, who may fall ill or migrate to other works, and in any case is useful only within a narrow range of conditions.

The development of the electrical pyrometer, therefore, to its present exceedingly high standard of accuracy and efficiency has conferred benefits upon certain industries which cannot be over-estimated, and it is gratifiying to know that it has been so very largely due to the efforts of British scientists and instrument makers. We have now reached a stage at which Mr. C. R. Darling, a recognised authority on this subject, is able to make the claim that British electrical pyrometers are in advance of all others. There is still plenty of scope for research in this field; we publish elsewhere a summary of recent improvements, which may serve also to indicate the directions in which progress is to be anticipated, and we hope that our lead will be maintained and increased.

THE CASE FOR THE ELECTRIFICATION OF CANE SUGAR MILLS AND REFINERIES.

By ERNEST P. HOLLIS, A.M.I.E.E., A.Am.I.E.E., M. Assoc. Mining Elec. Eng.

(*Concluded from page* 164.)

Before proceeding to a closer examination of electrification proposals, attention deserves to be paid to bagasse as a fuel.

The utilisation of the cane sugar refuse or bagasse as a fuel for steam-raising purposes is comparatively modern in origin, and whilst the chemical conditions attendant on its burning have been thoroughly investigated, it is, nevertheless, burnt very frequently on unscientific and inefficient lines. Since the complete electrification of a new mill or the overhaul of an old one would probably mean the installation of a new steam-raising plant, and since the benefits accruing from the employment of electricity as a motive force are so closely interlinked with the efficient burning of the fuel, it becomes desirable in connection with any discussion on the electrification of sugar mills to appreciate the position in regard to the burning of bagasse. In a majority of mills little care is given to the fuel. It is fed into a furnace chosen with no particular regard to the fuel which had to burn in it or to the conditions under which the fuel would burn best; the efficiency of combustion has therefore been small. If the end aimed at is to be realised—viz., that the bagasse shall supply the whole of the power of the mill—it must be burned under the most favourable conditions.

A typical sample of bagasse may contain, roughly, from 33 to 50 per cent. of fibrous matter, 32 to 56 per cent. of moisture, and some sugar. In addition, the hydrogen and oxygen present in the sugar and fibre occur in such quantities as to form moisture on burning, with the result that 1 lb. of bagasse contains on an average 0.215 lb. of carbon and 0.79 lb. of moisture. If the bagasse be burned just as it stands the heavy duty is imposed on the furnace of evaporating the moisture and raising it to the temperature of the flue gases, and, in addition, a much larger volume of air is admitted to the furnace due to the heavier rate of firing than would really be necessary if more perfect combustion were obtained. This point has been closely investigated recently, and it has been found that by drying the bagasse a great increase in efficiency is obtained. One pound of undried bagasse containing 53.7 per cent. of moisture evaporated 1.63 lb. of water from and at 212° F., whilst the dried bagasse having 46.3 per cent. of moisture evaporated 2.3 lb. from and at 212° F., which shows a gain in evaporative efficiency for the whole of the fuel burnt of 41 per cent. It is decidedly economical therefore to dry the fuel, for which purpose the waste flue gases are utilised.

A vertical chamber is inserted in the path of the flue gases which, propelled by a fan, pass upwards and emerge at the top. The bagasse enters at the top on a conveyor and falls downwards over a series of sloping drying trays, which are so adjustable in slope that they permit the rate of falling of the bagasse to be varied according to its wetness, giving it a greater or less time for drying. On arrival at the bottom the bagasse drops on to a conveyor and is passed on to the boilers.

To burn bagasse, specially designed boilers are imperative, having large combustion chambers and preventing the admission of too much air as the fuel is admitted. A Dutch-oven type of furnace appears to be the best practice, working in connection with water-tube boilers.

Outline of Electrical Scheme.—In putting the case for electrification before the manufacturer, it is of the greatest importance that concrete proposals for an electrification scheme be put before him, because there are so many special circumstances in sugar mills that put electrification questions on quite a different level compared with an ordinary works. In fact, the sugar mill is just as special as a colliery.

The following is an outline of a typical scheme. Steam would be generated in water-tube boilers, fired by bagasse delivered to the furnaces on a conveyor which passes through a chamber heated by flue gases in order to dry the bagasse before it is burnt. The steam would be superheated and passed on to extraction type steam turbines driving generators producing three-phase power at 50 cycles, and 440 volts, the generators working with an insulated neutral. The steam would be exhausted into a receiver. If it has to be transmitted any great distance care must be taken that a suitable amount of superheat is present, passing the steam, if necessary, through a superheater either separately fired or in the boiler furnace. This small amount of superheat has been found by experience to effect important reductions in the heat lost by the steam when passing through a long pipe-line.

The steam would then pass on to the building through a well designed pipe-line, and would arrive at the pans in a state of saturation. The electrical power would be distributed to the various buildings, inside which it would be carried by acid-proof insulated cables on porcelain insulators, or in well drained conduit according to the circumstances, in order to protect the cables from the effects of moisture. Three-phase motors would be used throughout of the squirrel-cage type for machinery such as the centrifugal pumps, which do not require a very high starting torque or an adjustable speed, while for centrifugals where adjustable speed was desirable, or for conveyors which might have to start up on a heavy load, slip-ring motors would be installed.* Naturally the crushers and rolls call for slip-ring motors. All motors exposed to moisture would be either totally enclosed or pipe-ventilated, and in those rooms where moisture was present only in small amounts, the windings of the motors would be specially impregnated, permitting semi-enclosed motors to be used.

In preparing the scheme of electrification for a sugar mill, a big fight has to be put up for the driving of the crushers, which may be compared in one respect to the winder at a colliery. As is well known, it is the practice to argue against the electrification of the colliery winder that as it consumes a large amount of power it is inefficient to convert the energy in the steam into electrical energy and then back again into mechanical energy, when the conversion into electrical energy may be avoided and the mechanical energy be taken direct from the steam. So it is said of the crushers, and in some large mills which employ electricity extensively the crushers are not electrified, the exhaust steam passing into the mains for steam heating the vats. During recent years, however, quite a number of these large crushers have been electrified, and, as might have been expected, it has been found that, while from the point of view of economy they have compared favourably with the steam drive, there have been other additional advantages which have amply justified electrification.

The Case for Electrification.—The first point to be made for electrification is that it effects such economy that the purchases of additional oil and coal are eliminated. These economies are realised in the following ways:—

(*a*) The introduction of electrification with a modern steam generating plant allows the utmost

* It is realised that for centrifugal driving the slip-ring motors with continuously rated rotor starters are quite satisfactory. There is no need to resort to the rather desperate expedient of a French sugar refinery where generators of different frequencies were installed, the motors momentarily taking their supply at a frequency giving the desired fractional speed.

to be made of what fuel is available, and enables it to be burnt under the most effective conditions.

(*b*) Electrification permits the concentration of the various smaller power generating units into a few large ones ensuring a far higher efficiency.

(*c*) Electrification permits turbines to be used instead of reciprocating sets. These turbines can be of the extraction pattern so that as much exhaust heat can be drawn off as required, and no more. The amount taken can be regulated at will.

(*d*) The long lengths of steam piping for carrying steam to various engines are eliminated. A small loss in the electric wiring replaces a much heavier loss in radiated heat.

(*e*) Power can easily be transmitted to distant pumps.

These and minor other considerations combine to increase the efficiency of the plant to such a point that not only no fuel need be purchased but a reserve of fuel is available to generate more heat to enable maceration to be carried much further, as mentioned previously. Illustrating this point, the bagasse comprises part juice and part fibre. About 12 per cent. of the total weight of the cane had consisted of sugar, and of this 10 per cent. has been removed at the crusher leaving 2 per cent. in the bagasse. Twenty per cent. of the total amount of sugar thus remains in the bagasse.

It is found in electrified mills that fuel is available to permit maceration to be carried on to such a point that half the remaining juice is extracted, thereby making a 10 per cent. increase in production.

Reverting to the question of electrifying the rolls, it will be found present in the minds of sugar manufacturers that steam driven rolls fulfil the very useful purpose of affording a supply of low pressure steam. But with electrification the whole of the exhaust steam is taken from the extraction turbines, and the amount taken is just what is wanted and no more. There is no waste of exhaust steam.

Facility of control is a great advantage in the electrically driven mill. There are no waits during the struggle to get the engines off the dead centres, and the steam packing replacements—a serious item—are eliminated.

A further valuable feature of the electric motor is its readiness to start at any time. Steam engines have to be dismantled, greased, repaired and reconstructed in the between-season hiatus. Indeed, the cost of this work, together with lubrication and packing, has been estimated at from three to four shillings per ton of sugar. This is eliminated with the electric drive.

Cylinder lubrication is an important matter. Oil is a deadly enemy of efficiency in steam heating systems, and though it is attempted to design these engines so that they need no cylinder lubrication, it is known that the drivers rarely fail to apply the oil either openly or surreptitiously. And the tale is soon told in the steam heating coils of the evaporator and so forth. The ability to stop or reverse the rolls rapidly have proved a useful feature of the electric drive when foreign objects have found their way in, or when, as is rarely the case, human life is endangered. On the other hand, the rapid acceleration of the electrical motor is appreciated.

In pumping work the excellent manner in which the motor and centrifugal pump "hit it" together, and the consequent installing of these combined units to replace ram pumps, makes a marked improvement in the operation of the plant. With a few exceptions, the whole of the pumping can be done by centrifugal pumps. Valve troubles and lubrication failures are eliminated.

Again, a saving in labour is effected; skilled labour is not necessary to start the electrical motor, whereas it is with the steam engine.

In conclusion, sugar mill-refinery electrification affords ample scope for good business for the manufacturer, and provided the scheme is tackled in the right way, results giving the fullest satisfaction to the consumer can be attained. There are here problems in steam and in electricity for solution, and, as in breweries, commercial success depends to an important extent on the arrangements adopted to secure the necessary adjustment between the energy taken from the steam for electrification and that for heating purposes. The actual technical electrical problems offer no cause for anxiety.

UNITS FROM REFUSE.

By JOHN B. MORGAN, A.M.I.E.E., Horsham U.D.C. Electricity Works.

The article in a recent issue of the Electrical Review on this subject is one that should engage the attention of every engineer who is anxious not only to reduce fuel costs, but also to render his undertaking as independent as possible of the unsatisfactory condition of the coal market.

Labour troubles and high prices have been, and are, a source of keen anxiety to those responsible for the running of many a generating station, and I quite agree that in neglecting to use house refuse as fuel a large waste of valuable material is going on.

Whilst in agreement, generally, with the author's deductions, I think his comparisons between South Wales refuse and other refuse that he has used should not be taken to apply generally. I believe that his experience has been gained in towns where coal is fairly cheap, and I venture to suggest that were he to see what a high degree of efficiency the householder has obtained in these parts in the art of scientific cinder sifting, he would agree that there is a vast difference between the calorific value of the house refuse of Cambuslang and Aberdare, and that of a small provincial town in the South of England. In this town (Horsham) house coal was sold last winter at 42s. per ton, and even now costs 35s. per ton. This, of course, works both ways: it results in poor refuse, but, at the same time, a ton of coal saved here has a greater money value than at Aberdare.

Perhaps the results of the working of our destructor will be of interest, as showing that, while we are not able to obtain such results as Aberdare, a refuse destructor is a thorough success, even in a small town working with low-grade refuse.

The population of Horsham is 11,900, and the town is the centre of an agricultural district. House coal costs 35s. to 42s. per ton, and coal for steam raising is proportionately dear.

The destructor is a two-cell plant in conjunction with a large water-tube boiler. The generating plant run in conjunction with the destructor is generally an 80-KW. high-speed set, condensing. The destructor is furnished with an air heater and motor-driven fan, and an economiser is installed in the main flue. The boiler is fitted with a superheater. These particulars will show that the plant, although small, is quite complete with all the necessities for economical running. The steam consumption for the set is 28·6 lb. per KW.-hour at full load, and 30 lb. at the average of the load at which it usually runs. The destructor plant is a recent addition, the combustion chamber having been built on to the side of an existing boiler setting. The boiler has a heating surface of 2,437 sq. ft.; the steam pressure is 160 lb., and the steam temperature averages 520° F. The boiler is furnished with an external coal-fired grate. The running conditions are as follows:—The destructor banked fires (refuse) are blown up, and steaming begins at 6 a.m., and continues on refuse until the day's collection is destroyed. During the summer months the coal fire has to be started about 3 p.m. In

the winter months the destructor often runs on until 6 p.m. The working of the destructor has been carefully recorded since its start, and the following figures are taken from my annual report to the Urban Council :—

Months.	Loads burnt.	Weight.	Running hours.	Weight per hour.	Units generated.	Units per ton.	Value of coal saved.	Clinker sold.	Scrap metal.
		tons.		cwt.			£ s.	tons.	£ s. d.
April ...	171	123·05	213·5	11·5	8,335	67·7	32 16	33·5	—
May ...	162	118·25	203·75	11·6	7,926	67·0	30 12	82·5	—
June ...	156	116·85	179·5	13·01	6,693	57·2	26 13	2·0	7 19 2
July ...	167	118·40	176·0	13·4	6,651	56·2	27 15	17·5	—
August	150	104·45	145·0	14·4	5,425	51·8	21 7	23·0	—
Sept. ...	153	109·85	168·5	13·03	6,104	55·7	18 19	28·0	—
October	159	114·7	206·25	11·12	7,900	68·8	19 13	32·5	—
Nov. ...	149	109·5	222·0	9·8	10,680	97·5	25 9	101·0	—
December	173	129·65	238·0	10·8	12,964	100·0	31 10	132·0	—
January	169	122·95	225·25	10·9	12,982	105·5	30 7	1·0	3 15 2
February	162	118·65	228·75	10·3	10,628	89·5	27 12	127·0	—
March ...	182	135·5	252·0	10·7	10,402	76·8	27 15	150·0	—
Totals ...	1,953	1,421·80	2,458·5	11·5	107,690	76·1	320 8	730·0	11 15 0

An average of 76·1 units per ton is recorded for the whole year. As before mentioned, the destructor steams the day load, which is, in our case, the most inefficient condition of running. As an experiment, on one occasion we steamed the day load on coal and used the refuse on the evening load. The better running conditions gave us a figure of 120 units per ton. These results of ours compare very closely with those of Aberdare. Our running conditions are more efficient, but our refuse is of very poor quality. At this time of the year it is very little more than vegetable refuse, and there is no doubt that with refuse of fair quality and turbo-driven generators, it should be easily possible to obtain 200 units per ton of refuse destroyed.

Previous to the installation of the destructor, the refuse was carted to local brickyards on the town borders, where it was allowed to lie in unsavoury heaps until all vegetable matter was decomposed, leaving a residue of cinders, &c., which were used for brick burning.

BALANCE SHEET.

INCOME.

Coal saved	£320 0 0
Income from by-products	68 9 0
	£388 9 0

EXPENDITURE.

Interest and sinking fund	£178 15 0
Repairs	4 0 0
Labour	78 0 0
Balance, being net profit	127 14 0
	£388 9 0

This financial summary shows that a carefully-planned scheme can be operated to the benefit of the town and also of the undertaking, by rendering the generating station less dependent on coal supplies. In many towns the refuse costs considerable sums to cart away, and money would be saved on this item alone ; but, in our case, no cartage or disposal expenses are saved, and so the electricity department is charged a sum for the refuse equal to the amount of interest and sinking fund on the loan, and as the destructor is under the electrical engineer's control, the stoker's wages are also charged.

Knocked Out of Time.—As a result of a serious thunderstorm which passed over Edinburgh one day last week, the famous one o'clock time gun at the Castle was not fired. Certain electric circuit clocks in the city and the one o'clock gun are controlled from the Royal Observatory on Blackford Hill, and it appears that the controlling wire was struck by lightning. By this means the electric discharge entered the building and damaged an ammeter and a relay, with the result that the gun was put out of action.

NEW ELECTRICAL DEVICES, FITTINGS AND PLANT.

Portable Searchlamp.

A powerful portable searchlamp operated from a storage battery has recently been developed by Thomas A. Edison, Inc., Orange, N.J., in co-operation with the GENERAL ELECTRIC CO., Schenectady, N.Y. Use is made of a 20-in. waterproof projector and a 35-volt, 750-watt focus-type nitrogen-filled lamp. The projector and battery are mounted on two wheels by means of trunnions, so that the apparatus can easily be handled by one man.

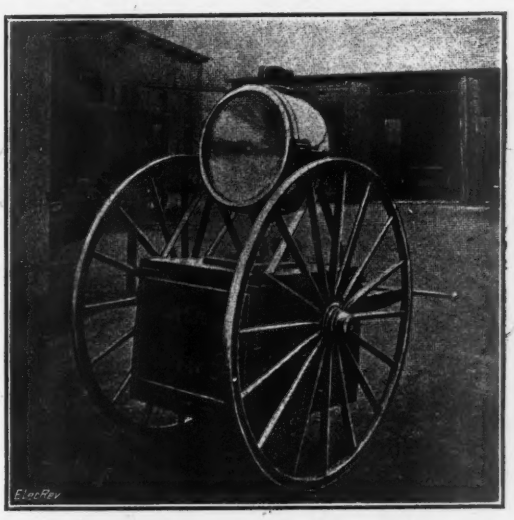


FIG. 1.—PORTABLE BATTERY-OPERATED SEARCHLIGHT.

The outfit is approximately 5 ft. high, 3 ft. wide and 3 ft. long. It weighs 600 lb. and is designed to operate continuously for seven hours on one charge. The concentrated beam is sufficiently powerful, it is declared, to show objects half a mile away. By use of the adjustable focussing device, the light may be spread out in fan-shaped beam for close-range work. The equipment is designed particularly for city and factory fire departments ; it is also well-adapted for night construction work, illumination of advertising, &c.—*Electrical World.*

An Australian Automatic Cut-Out.

Mr. Turnbull, assistant engineer with the N.S.W. Government Railways and Tramways, and the inventor of a special type of windmill for electric driving which has achieved popularity in that State (and was described in our columns), has recently introduced a novel form of automatic "cut-out" more particularly for use in connection with windmill plants, where the generator is continually "cutting-in" and "cutting-out" with the battery whenever the wind velocity rises or falls.

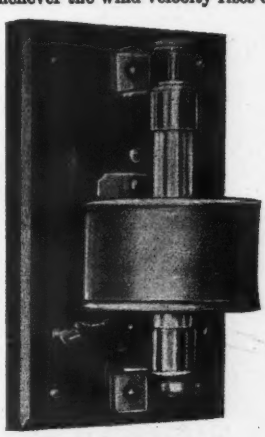


FIG. 2.—TURNBULL AUTOMATIC CUT-OUT.

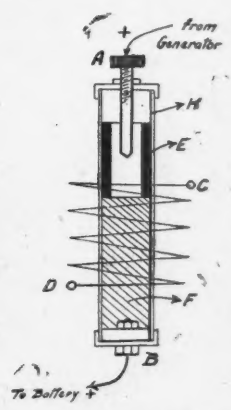


FIG. 3.—DIAGRAM OF AUTOMATIC CUT-OUT.

Mr. Turnbull claims to have produced an apparatus which satisfactorily meets these conditions, but which is so simple in construction that its manufacturing cost is extremely moderate in comparison with that of existing designs ; this device was recently described in the *Commonwealth Engineer*, from which we gather that in the diagram, fig. 3, H indicates a glass tube, closed at the top and bottom by metal covers, through which pass iron or nickelled copper terminals A and B, of which A is adjustable within wide limits.

The tube is about half filled with mercury, covered with a slight amount of light oil. Floating on the mercury is an iron cylinder E.

Surrounding the tube, but separated from it by an air space, is a shunt coil, C D, which is connected across the positive and negative mains leading from the generator.

The generator positive is connected to A, while B is coupled to the battery positive, the generator and battery negatives being directly coupled.

A predetermined rise in generator voltage results in the cylinder E being sucked down owing to the action of the coil C D, thus forcing the mercury up to meet the upper terminal A, and completing the circuit from generator to battery.

Owing to the fact that the iron cylinder will rise again, due to its buoyancy in the mercury, any reversal of the current is impossible; in order to ensure that this action is definite, and to correct the possible instability of the mercury in cylinder E, owing to extreme sensitiveness of movement of the cylinder, a few series turns are added to the shunt coil.

It is stated that, in practical use, the apparatus acts not only satisfactorily, but perfectly.

Glasshouse Pot and "Vitrite" Cap Making at the Ediswan Works.

The accompanying illustrations relate to a very interesting industry, which is little known to the electrical trades, but is carried on by the Edison & Swan United Electric Light Co., Ltd., at their Ponder's End works. This industry is glasshouse pot making, the pots being used in the manufacture of glass for the Royal "Ediswan" lamps.

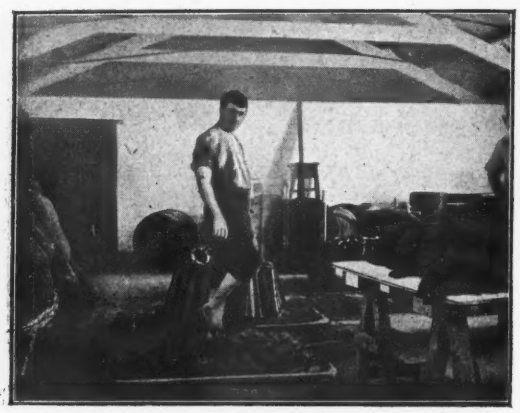


Fig 4.—Tempering the Clay for Pots.

The views show the interior of a room specially built for the making of glasshouse pots; this room when filled holds 120 pots of a size suitable for the company's furnaces. The clay of which the pots are made comes from the Stourbridge district, and is the finest mixture which can be procured for this class of work; it is delivered to the works in bags in a dry state, and is taken in hand by skilled workers who add the requisite amount of water, after which the clay is allowed to stand by for a time. It is afterwards tempered, being turned and trodden by skilled men with their bare feet (see illustration) until it is in a sufficiently plastic state for the pot maker to start operations.

Fig. 5.—Glasshouse Pot Stores.

These pots require to be made at least 12 months before being used, the method adopted here being to dry them to a sufficient state of hardness to allow of their being moved to a room where more direct fire heat is allowed to play on them until they are sufficiently hard or dried to be transferred to the pot arch, when they require at least 14 days to burn sufficiently to temper them before being transferred to the furnace, ready to be charged with the ingredients for the manufacture of the glass. The last illustration shows a machine for "Vitrite" lamp-cap making at the works. Formerly such caps were almost wholly of foreign production, but the caps used in the "Royal Ediswan" lamps are entirely manufactured at the Ponder's End works.

Fig. 6.—"Vitrite" Lamp-Cap Making.

Seamless Tubing.

We have already noticed the seamless steel tubing manufactured by the Ellwood Ivins Tube Works, Oak Lane Station, Philadelphia, Pa., U.S.A. Further samples have now been received, including one of about No. 24 S.W.G. of seamless high-grade tool steel, a remarkable production; we are informed that it was made from the solid bar, and the sample was cut from a 75-foot coil. Larger tubes are made, up to 4 in. in diameter, in tool steel, low carbon steel, copper, brass, aluminium, &c., accurate to $\frac{1}{1000}$th of an inch. Certainly we had not thought that the production of a thin steel tube $\frac{1}{64}$th in. in diameter was possible.

WAR ITEMS.

The War and Electrical Supplies for South Africa.—*The South African Mining Journal* comments as follows:—'As the weeks roll by the difficulty of obtaining supplies of electrical goods becomes greater. Round blocks, 3½ in. for wall switches, are so scarce that two local mechanics have commenced making them at 3s. 6d. per doz., as compared with imported at 1s. 6d. under normal conditions. Ceiling roses are unobtainable in any quantity. Double pure rubber flex up to municipal standard has advanced 100 per cent., and is very difficult to obtain at that. Coils of wire have gone up to such an extent that in some cases it makes it difficult for the smaller contractors to tender, especially as all other electrical goods have gone up from 20 to 25 per cent. and supplies cannot be relied on at these enhanced values, therefore the firms holding stocks necessary for a contemplated contract are the only people who can tender with any safety. Glass lamp shades, as well as all kinds of porcelain ware, have risen anything from 100 to 300 per cent. since the war started, simply because the Continental supplies have had to be replaced with British and American goods, also a few consignments from Holland. It is recognised that electrical smalls require very good and up-to-date machinery, which can only be provided by manufacturers dealing with big outputs, therefore very little can be done in a limited period, and not much can be expected from the Johannesburg factories, but what small makers are doing is to use up second-hand parts and put them together for lampholders and such like articles, at a cost of about double the imported; but what is that when any special lines are wanted for actual use? What is surprising is that the ordinary lamps have not advanced much, which is explained by the fact that a British lamp was specially designed and made for the purpose of competing with the Continental variety, and ran neck and neck with the latter as regards the price before the war."

History Repeating Itself.—A note in the *Times Engineering Supplement* reminds us that the Carron Co., which has been established for over one and a half centuries, made quantities of shrapnel shell, under the inventor, Major Shrapnel, in 1803 and 1804, and that the carronade, which was adopted by the British Navy in 1779, was so called because it was first cast at the Carron Works.

Australia and Metals.—A Reuter dispatch, dated Melbourne, August 4th, states that on the previous day Mr. Hughes (the Commonwealth Attorney-General) conferred with representatives of the Mount Morgan Gold Mining Co. and the Electrolytic Co. regarding the position of the Electrolytic Co., the exclusion of the Hirsch interest, and the general development of the copper industry in Australia. In the Victoria Legislative Assembly, Mr. Mackinnon (the Attorney-General) introduced a Bill providing for the cancellation of all enemy contracts.

In connection with the foregoing, Reuter's Agency in London states that at the outbreak of the war the Mount Morgan Gold Mining Co. and the Electrolytic Co., with which it works, found their operations practically brought to a standstill by reason of their comprehensive contracts with German firms, including Aron Hirsch & Sohn, which company also held an interest in the Electrolytic Co. It is now intended to reconstruct the Electrolytic Co. in such a manner as to exclude the German interest, and the freedom of the Australian companies from German claims will be secured under the legislation which has been initiated.

CORRESPONDENCE.

Letters received by us after 5 P.M. ON TUESDAY *cannot appear until the following week. Correspondents should forward their communications at the earliest possible moment. No letter can be published unless we have the writer's name and address in our possession.*

Limitation of Price Coal Bill.

I should like to draw your attention to a point in the above Bill which appears to be somewhat unfair, and which, so far, seems to have escaped criticism.

I understand that the said Bill limits the price of coal at the pit head to that obtained during the year immediately preceding the war, plus an addition of 4s. per ton, to cover increase of costs owing to the war. Apparently, the additional 4s. per ton is to apply to all qualities of coal, so that the maximum price of "gum coal," which previous to the war could be bought at the pit head for 4s. a ton, will be fixed at 8s. per ton—that is, an increase of 100 per cent.; whereas in the case of coal used for household grates, which previous to the war could be purchased at 20s. per ton, an addition of 4s. per ton represents an increase of 20 per cent. only.

Would it not be more equitable to state the additional sum allowed to cover the increased costs owing to the war as a percentage on the pre-war price, instead of a fixed sum of 4s. per ton?

Roland Marshall.

Electricity Works, Ayr, *August 4th*, 1915.

THE ELECTRIC COOKING PROBLEM: AN AMERICAN EXPERIMENT.

WRITING in the *Journal of Electricity, Power and Gas*, of San Francisco, Mr. R. E. FRICKEY, engineer to the Northern California Power Co., at Redding, Cal., discusses a solution to the above problem, bearing in mind the American view that electric cooking has been held back, owing to (1) high cost of cooking apparatus, (2) high cost of operation due to (*a*) inefficient application of heat, hence high KW.-hr. consumption, (*b*) heavy demand of apparatus, hence large element necessary in rate for interest, depreciation, and maintenance of services, meters, mains, etc., (*c*) high peak load overlapping normal station peak, hence large element in rate for station apparatus, (3) high cost of hot-water supply. Mr. Frickey realised these obstacles and believes he has found, for certain local conditions, a solution of the problem, by the use of a thermal storage cooker, one type of which is illustrated herewith.

This apparatus has an internal heating chamber containing a number of cast-iron disks or radiators which are maintained at practically constant temperature by a surrounding heating element which is kept in constant service, except under circumstances referred to later. A cooking chamber is above the heating chamber, with a movable intervening cover, and the upper chamber is provided with a hinged steam-tight lid. Both chambers are surrounded by heat insulation and an outer water jacket, also heat insulated; means are also provided for filling and drawing off water from the jacket, and an immersion type heater can be provided, for hand or automatic use.

Most of the heat flows outwards to the water jacket, the insulation being so designed that the temperature drop with the normal heat flow, plus the fairly constant water temperature, is equal to the temperature desired in the heating chamber.

Again, the cooking chamber is separated from the water reservoir by suitable insulation; this insulation, as well as the metal lining of the chamber, is maintained at a high temperature, both by the surrounding hot water, and by the heat leaking through the cover of the heating chamber.

The water jacket is constructed of tinned copper, and the cooking chamber is lined with seamless drawn aluminium.

A convenient single-phase A.C. electromagnet is provided for lifting the cover of the heating chamber and the radiators, one at a time.

Broiling, frying and similar operations cannot be performed in the cooker. For these operations a special radiant grill, having a demand of 700 watts (say, one horse-power) has been found adequate. This grill is 8¼ in. in diameter and is designed to broil or fry, as required; the demand of this grill fixes the maximum demand of the entire apparatus for general cooking. This is so because the heating element within the cooker may be disconnected for short intervals without appreciably changing the temperature of the radiators; in practice, a double throw switch is used to disconnect the cooker while the grill, or other special device, as a percolator, is being used.

For many cooking operations, the cooking chamber may be

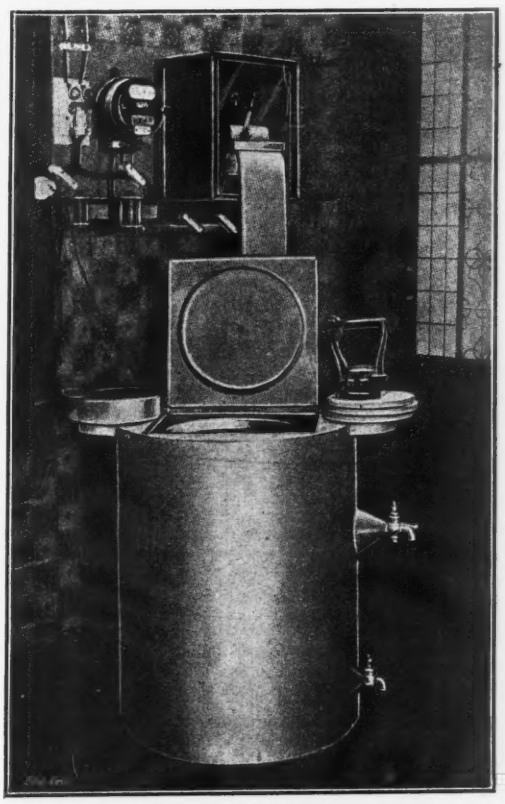


FIG. 1.—ELECTRIC THERMAL STORAGE COOKER UNDER TEST.

used without radiators and without previously heating the food. In this manner cereals, rice, beans, and similar food, are thoroughly cooked over night. The energy for these operations comes through the cover over the heating chamber. For most cooking operations a single hot radiator is transferred to the bottom of the cooking chamber. For roasting and for baking operations a radiator is used both below and above the food. When baking two or more pies or cakes at one time, one radiator more than the number of articles is used.

A convenient attachment is furnished with the cooker as an extra. This consists of a radiant electric grid covered by a reflector and air baffle. A tube normal to the reflector at its centre point carries the feed wires. To use the attachment, the cover of the cooker is raised and the tube is inserted through the steam valve opening in the cover. The cover is then closed and by means of the tube and suitable thumb screw the grid is adjusted to the proper height above the food to be cooked.

This device is really not needed for baking or roasting, but many remarkable effects can be obtained by its use; the loading is 400 watts.

The author considers that the results obtained are superior and the operations more simple than for the ordinary fireless cooker. The cast-iron radiators or heaters are always ready for use; the cooking chamber is maintained at a constant temperature because of the equalising effect of the water jacket and heating chamber cover.

An input of 200 watts has been found sufficient to heat ten radiators daily, and to furnish five gallons of water

daily, at a temperature sufficiently high for all domestic purposes. This number of radiators has been found to be adequate for cooking for a family of from five to ten people. Additional hot water may be obtained as desired by the use of the immersion heater within the water jacket, but it

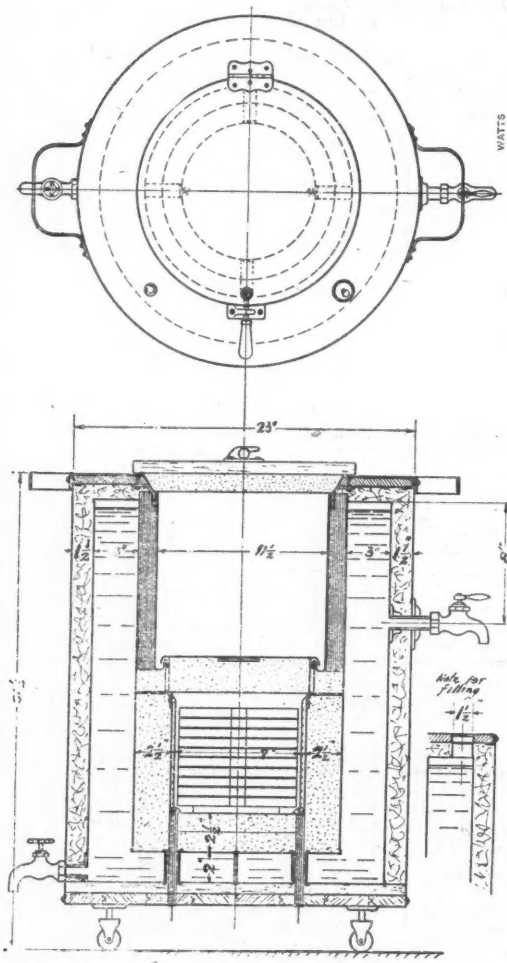


Fig. 2.—Plan and Section of Thermal Storage Cooker.

should be remembered that the energy used for this purpose is utilised at nearly 100 per cent. efficiency, since all losses are already accounted for in the 200 watts normal input. If a constant daily demand exists for more water than is normally provided, this should be obtained by a constant input, providing additional unity load factor load.

ing of his type of cooker. With the usual type of range 3,901 watt-hrs. were required for this dinner, but only one gallon of water was provided, as compared with two in the author's case.

The graphic curve shown in fig. 3 gives particulars of the

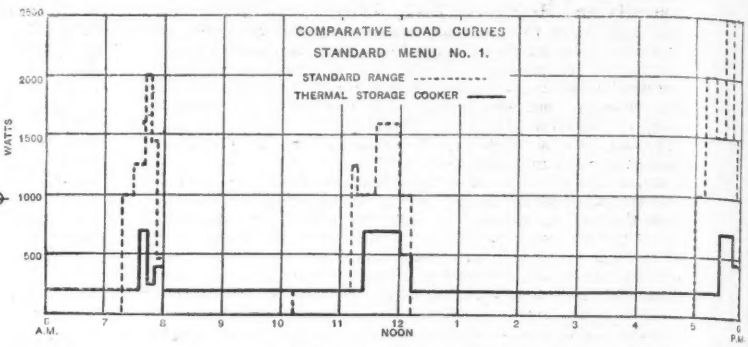


Fig. 4.—Comparative Load Curves for Standard Menu.

energy consumption of the thermal storage cooker in this case; for the rest of the day, there would be a constant load of 200 watts.

The author gives a further comparison in regard to a "standard" daily menu, covering breakfast, dinner and supper, the comparative load curves superimposed being shown in fig. 4.

The maximum possible demand of the range was 3,600 watts, though the highest demand shown in fig. 4 is 2,500 watts; the maximum possible demand of the cooker is 700 watts. The cooker also produced 5 gallons of hot water in addition, while the range produced none except that used in the cooking operations; this additional hot water would have cost 6.7c. if obtained by the method of the range at 3c. per KW.-hr.

The author concludes by pointing out that some coast companies are catering for irrigation business, giving an income of about 1 cent per KW.-hr., in every case building the supply lines, and expresses the opinion that if the power companies are willing to sell 100 per cent. load factor energy at the same price for the cooker described, a new era in electric cooking will result; he adds that the complete cooking equipment will cost less than the cost of transformers, services, and meters required for a standard range.

RECENT PROGRESS IN PYROMETRY.

By CHAS. R. DARLING, A.R.C.Sc.I., F.I.C.

(*Abstract of paper read before the* Royal Society of Arts.)

In 1910 the author delivered four Cantor lectures before the Society on the subject of "Industrial Pyrometry," which contained an account of the appliances in use at that time.

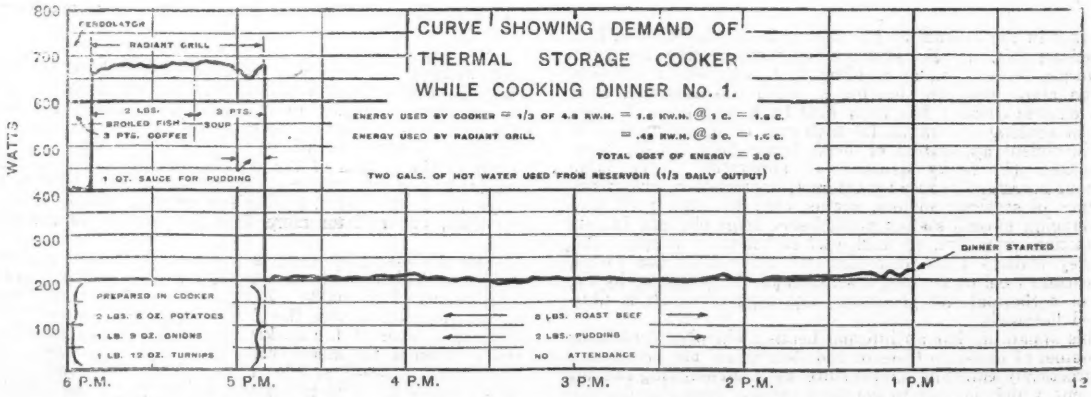


Fig. 3.—Load Curve of Thermal Storage Cooker while Cooking a Dinner.

At 100 per cent. efficiency, approximately 10 gallons of water may be heated in 24 hours from 20 deg. C. to 75 deg. C. with an input of 100 watts.

Under this condition it is possible economically to meet all demands for hot water for domestic uses. The cooker described has been thoroughly tested under working conditions, and the author, taking a recent commercial report upon an ordinary electric range, with which the energy used for each operation and load curves were given for the preparation of a "standard" dinner, makes a comparison with the work-

During the intervening period many improvements have been introduced, and many new instruments designed.

Apart from the work of Government institutions such as the National Physical Laboratory, practically all recent progress in pyrometry has been due to the efforts of instrument-makers, and little of importance has emanated from our educational institutions. As the result of scientific methods, British makers of pyrometers are not merely independent of other countries, but stand unrivalled in regard to the quality and accuracy of the instruments they supply.

During the period under notice no pyrometers based upon new principles have been introduced, and the advances made, therefore, relate to methods previously in use, which it will be convenient to consider under separate headings.

Thermoelectric Pyrometers.—The past few years have witnessed a great extension of the use of base metals in the construction of thermal junctions. This has been due not merely to the almost prohibitive price of platinum and kindred metals, but to the fact that properly-chosen base-metal couples develop a relatively high E.M.F., and therefore enable a strong and cheap indicator to be used in place of the sensitive instrument required for couples of the platinum series. The chief base-metal couples in use in this country are composed as follows:—

Positive.	Negative.	Highest working temperature.	Maker.
Iron	Constantan ...	900° C.	All British firms.
Iron-nickel alloy	Iron-nickel alloy of different composition	1,000° C.	R. W. Paul.
Nickel-chromium alloy	Nickel-chromium alloy of different composition	1,200° C.	Foster Instrument Co.

For occasional readings, the last-named junction may be raised about 100 deg. C. above the limit mentioned. For work at lower temperatures than 700 deg. C., copper-constantan junctions are frequently used, as, for example, in measuring the temperature of superheated steam. Numerous other combinations are used, particularly in the United States.

Considerable doubt has been thrown on the reliability of base-metal junctions by Kowalke, who investigated a number of couples supplied for commercial purposes by American makers. In all the cases examined sustained heating for twenty-four hours was found to alter the calibration by amounts varying from 20 deg. C. to 130 deg. C., the departure being most noticeable at the higher temperatures used —800 deg. C. and 1,000 deg. C. Depth of immersion in the furnace was found to cause discrepancies in the indications, and the general results showed that large errors might arise owing to defects in the couples sent out by the makers. With most of the junctions, however, it was found that prolonged heating induced a practically stable condition, and the conclusions to be drawn were: (1) the couple should be "aged" by continuous heating at its upper temperature limit before calibration; (2) the depth of immersion during calibration should be the same as that obtaining when the pyrometer is in use; and (3) metals which form solid solutions with one another give the best results. Since the publication of Kowalke's work, I have tested an iron-constantan pyrometer which has been in use in my own laboratory for nearly three years, during which time it has been repeatedly heated to 850 deg. C. At the melting-point of zinc (419 deg. C.) the calibration was strictly correct, and at 800 deg. C. the reading was only 5 deg. too low. This pyrometer is of the heavy type, made by welding a constantan rod to an iron tube, and the slight error thus shown after repeated use compares favourably not only with junctions made of platinum and its alloys, but with any type of pyrometer whatsoever. The general experience of users of base-metal couples of British manufacture is that the changes in calibration are much less than those recorded by Kowalke, which, if generally true, would entirely discredit this class of instrument.

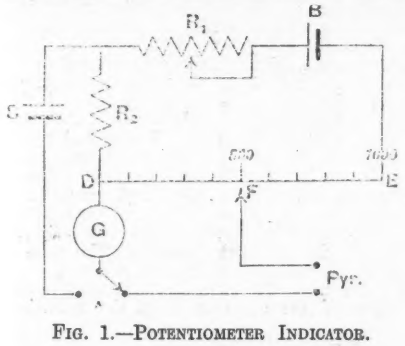


Fig. 1.—Potentiometer Indicator.

An interesting investigation of junctions of carbon and graphite has been made by C. C. Bidwell, who finds that by the aid of these materials temperatures as high as 2,000 deg. C. may be read. It is necessary to subject the junction to a preliminary heating at this temperature before calibration, in order to remove volatile impurities, when constant readings can be secured. Both carbon and graphite can be obtained in thick rods, and can be machined, so that it is possible to build up a robust pyrometer with these substances. If this couple be found to meet the requirements of industrial practice, it should prove extremely useful for temperatures exceeding 1,200 deg. C., and may solve the outstanding problem of determining the temperature of molten steel in the ladle. Its utility in experimental work is already established.

Several new materials have been introduced to form the protecting sheaths necessary to shield junctions from the corrosive action of furnace gases. Alundum (oxide of aluminium) is now used for this purpose; but although it possesses a high melting-point (2,050 deg. C.) it is too permeable to gases, particularly at high temperatures, to be of general service. The same remark applies to a new material of the carborundum type, known as "silfrax," recently introduced in the United States. Another material with a carborundum basis, called "silit," is said to give satisfactory results. All the three substances named are brittle, and consequently cannot be subjected to rough usage. A new type of sheath, for use with molten brass or bronze, possesses a tip of molybdenum, connected to a nickel tube covered with a protecting material, so that only the molybdenum and the protection come into contact with the metal. As molybdenum is a good conductor of heat, and only a thin tube is used, a rapid reading of the temperature is obtained, the molybdenum being unacted on by the molten metal. This sheath is said to be entirely satisfactory for this purpose; if so, a troublesome problem in pyrometry may be regarded as solved. Foster's method, in which a junction of Hoskins' alloys is dipped directly into the molten brass, gives rapid readings, but the junction is gradually eaten away.

A new departure in the method of indicating temperatures in commercial instruments has been made by the Leeds and Northrup Co., of Philadelphia, who have adopted the potentiometer principle, previously only employed for accurate laboratory work. The electrical connections of an instrument of this kind are shown in fig. 1. A current from a two-volt accumulator B, passes through an adjustable resistance R_1, a fixed resistance R_2 and a uniform stretched wire DE. At the point D is attached one terminal of a sensitive galvanometer G, the other terminal being connected to one contact of the pyrometer. The remaining wire of the pyrometer is fastened to a sliding-wire contact, F, which may be moved along DE. A standard cell, S, is permanently connected to R_2, and may be joined to the galvanometer when desired by means of the switch A. To commence with, S is connected to the galvanometer, and R_1 adjusted until no deflection is obtained. The switch is then turned over to the pyrometer, and the slider F moved along the wire until the deflection is again zero, when the fall of potential between D and F will be equal to the E.M.F. of the heated junction. From the relation

$$\frac{\text{E.M.F. of junction}}{\text{E.M.F. of standard cell}} = \frac{\text{Resistance of } DF}{R_2}$$

the E.M.F. of the junction is determined; and as the temperature corresponding to this is known by previous experiments, the point of balance on the wire may be marked with this temperature. Similarly, the whole length of the wire may be divided so as to read temperatures directly. It is essential to accuracy that the fall of potential along DE must not change; and as the voltage of the working cell B falls off with use, R_1 must be adjusted from time to time, so that when the standard cell is coupled to the galvanometer no deflection is obtained. The advantages possessed by an indicator of this kind are (1) great sensitivity, allowing the use of a large scale on which small differences of temperature may be read; and (2) the fact that the readings are independent of the resistance of the pyrometer, and its leads. On the other hand, an adjustment is necessary before taking a reading, and the working cell must be re-charged or renewed from time to time. A skilled observer could obtain closer readings than would be possible with an ordinary indicator, but in the hands of an untrained workman difficulties in use might easily arise.

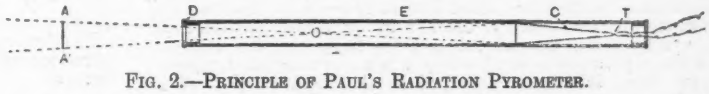


Fig. 2.—Principle of Paul's Radiation Pyrometer.

Another adaptation of the potentiometer principle to indicators has been introduced by the Cambridge Scientific Instrument Co., with a view to obtaining closer readings over a given range. If an indicator be graduated from 0 deg. to 1,000 deg., and the working range be 500 deg. to 1,000 deg., the useful part only occupies one-half of the scale, and accuracy of reading is thereby restricted. If, however, it can be arranged that the pointer remain in the zero position until the pyrometer has reached 500 deg., the whole scale may then be used for the interval 500 deg.-1,000 deg., thus enabling finer readings to be taken. The way in which this may be accomplished may be understood by reference to fig. 1. If the galvanometer, G, be replaced by an indicator, coupled up so that the fall of potential between D and F opposes the movement of the pointer due to the pyrometer, no deflection will occur until this E.M.F. is overcome. If the value of the opposing E.M.F. be equal to that developed by the pyrometer at 500 deg., the pointer will only commence to move when this temperature is attained, and hence the whole scale may be devoted to the range 500 deg.-1,000 deg. Assuming that the indicator be sufficiently sensitive, it is evident that a full-scale reading could be obtained for a less interval—say 200 deg.

—the commencing temperature being regulated by altering the position of the contact *F*. In one form of indicator arranged on this principle, the changes in the voltage of *B* are automatically compensated by the standard cell; in a simpler form, the standard cell is abolished, and the varying voltage of *B* allowed for by adjusting resistances in a circuit until the indicator, on being switched into this circuit, shows exactly full-scale deflection.

A similar result to the foregoing is attained by a different method in the instruments made by R. W. Paul. In these, the indicator takes the position of the galvanometer in a Wheatstone bridge, the pyrometer being in the indicator circuit. By adjusting the resistances in the arms of the bridge, a small current from the external battery may be caused to pass through the indicator so as to oppose that due to the pyrometer. This opposing current may, for example, be regulated so that the pointer of the indicator remains at zero until the pyrometer has attained 500 deg., thus leaving the whole scale available for graduation from 500 deg. upwards. Examples of useful ranges on instruments furnished with a double scale are appended :—

Junction.	Full range, °C.	Special range, °C.
Two iron-nickel alloys ...	0 to 1,000	700 to 900
Platinum—Pt Ir	0 to 1,300	600 to 900
Two rhodio-platinum alloys ...	0 to 1,600	500 to 1,100

Combined with this Wheatstone bridge arrangement is a device for correcting automatically for changes in the temperature of the cold junction. In the four arms of the bridge two of the resistances are of manganin, which are unaffected by temperature changes, whereas the other two are of copper, which alters in resistance on heating or cooling. The bridge is accurately balanced at 20 deg. C., but at any other temperature a small current will pass through the indicator, the direction of which will depend upon whether the resistances have been raised or lowered in temperature. The cold junction is located so as always to possess the same temperature as the resistances, which are regulated so that the movement of the indicator pointer, when the bridge is out of balance, covers an amount of the scale representing the difference between 20 deg. and the temperature of the cold junction. This compensation is arranged to hold either for full or special range.

A mechanical "hold-up" for special range work has recently been devised by the Cambridge Scientific Instrument Co. In this case the indicator possesses a suspended coil, and by turning a graduated head a twist is imparted to the suspension, opposing that due to the current passing from the pyrometer through the coil. By turning the graduated head to a given mark, the zero of the indicator may be made to represent, say, 500 deg., and the whole scale used for the remainder of the range.

The general use of superheated steam in engines, including locomotives, has opened a wide field for the useful application of pyrometers. In this instance it is necessary to arrange the pyrometer to withstand pressure, and to provide fittings whereby it may be fastened to a steam-pipe. Thermal junctions of copper and constantan are usually employed. In the case of locomotives, an indicator unaffected by vibrations is requisite, and can now be supplied by the various makers.

Resistance Pyrometers.—There are few changes to record in connection with this class of instrument, the patterns in use five years ago having undergone little modification. Platinum, which is the metal invariably used, has been shown recently by Sir William Crookes to be measurably volatile above 1,000 deg. C., and this explains fully why the readings of these pyrometers went astray when a continuous temperature above this figure prevailed in the furnace. For work at low temperatures, such as occur in connection with cold storage, and also for use in chemical operations at moderately high temperatures, the resistance pyrometer is to be preferred on account of its greater accuracy, and its use for such purposes is extending rapidly. An installation, consisting of a number of instruments connected to a single indicator through a switchboard, is now a common feature in cold stores or up-to-date chemical works. By its aid the attendant can read the temperature at any point by switching the pyrometer located at the spot on to the indicator, and the accuracy of the reading may be either 1 deg. or less if desired. For metallurgical work, resistance pyrometers find an application in cases where great accuracy is essential, and where provision is made to secure a precise adjustment of the temperature of the furnace. A common practice in large establishments is to use thermoelectric instruments for the ordinary work, but to keep one or more resistance pyrometers for specially accurate work, and for checking the various indicators in general use. This is sound practice, as it makes the best use of both systems.

Reference may be made here to the interesting researches of Northrup, which give promise of an extension of the resistance method to a range of temperature beyond its present limit of 1,000 deg. C. Northrup found that certain metals, such as copper, increase steadily in electrical resistance up to the melting-point, and that in the process of melting the resistance is doubled in value, after which the resistance of the molten metal increases uniformly as the temperature rises. It may be possible to devise an instrument in which the temperature is deduced from the resistance of a molten metal; if so, the range of resistance pyrometers could be extended to at least 1,400 deg. C., and higher than this if a protecting sheath capable of withstanding a greater temperature could be found. Another possible extension of the resistance method is suggested by the change in resistance shown by pyro-conductors with rise of temperature. These bodies, of which glass is an example, decrease in resistance with rise in temperature; thus alundum, at 1,100 deg. C., has a resistance of 6,100 ohms per cm. cube, which falls to 190 ohms at 1,600 deg. C.—an average decrease of nearly 12 ohms per degree. A very coarse instrument would readily detect a change of this order, and further investigations in this direction may lead to a pyrometer based on this phenomenon.

Radiation Pyrometers.—The drawbacks incidental to the use of thermoelectric pyrometers for temperatures exceeding 1,000 deg. C. have led to a wide adoption of the radiation method in processes involving readings about this point. The Féry pyrometer, made by the Cambridge Scientific Instrument Co., is extensively used, and has been improved in details. In the early form, a suspended-coil galvanometer was necessary as indicator, owing to the low E.M.F. developed by the junction on which the rays were focused. The use of an alloy of antimony and zinc, in atomic proportions, as one of the junction materials, has enabled pivoted indicators to be used, owing to the greatly increased E.M.F. obtained, which is a great advantage from the standpoint of portability. The gilt mirror formerly used has been superseded by one of a special alloy of higher reflecting power, and the focusing head graduated so that, without sighting, the pyrometer may be focused for any desired distance. Whipple has applied this pyrometer to the determination of the temperature of molten metals by mounting it at the open end of a fireclay tube, the closed end of which is dipped into the metal, and kept permanently in focus. By this means readings as high as 1,500 deg. C. have been taken in small ladles, but so far it has not been found possible to apply the method to large masses which cannot be approached closely.

Foster's fixed-focus instrument has also proved quite satisfactory for general workshop requirements, and has found many applications. This pyrometer as used for molten metals is attached to a fireclay tube, the closed end of which is immersed in the material. A feature of this arrangement is a vertical ventilating tube in front of the mirror, which prevents metallic fumes rising from the fireclay tube, in case of breakage, from entering the upper end of the telescope, and thus avoids any damage which might arise from this cause. Being mounted on a light tripod, the instrument is portable, and can be adjusted in height as required. A pivoted indicator is used. A special form of this pyrometer, designed for lower ranges, such as 500 deg. C. to 1,000 deg. C., can now be procured. Another form of fixed-focus pyrometer, due to Thwing, has been marketed by R. W. Paul. The principle of working is shown in fig. 2, where *E* is a tube containing a polished cone, *C*, at the apex of which is fixed a thermal junction, *T*. Rays from the hot source *AA'* enter the tube at *D*, and pass into the cone, being finally reflected on to *T*, which is connected to the indicator. So long as the lines joining the outside of the cone with the extremities of the entrance *D*, crossing at *O*, fall within the hot source, *AA'*, the reading will be the same at all distances. The actual pyrometer is mounted on a tripod, with a Unipivot galvanometer as indicator, the scale, as in all radiation pyrometers, being divided into temperatures according to the fourth-power law.

The certificates issued by the National Physical Laboratory with radiation pyrometers of all types mentioned indicate the high degree of skill shown by the makers. The corrections are invariably small, and sometimes non-existent.

Mention may be made here of the results of various determinations of the value of the constant *K* in the radiation formula

$$E = K(T_1^4 - T_2^4),$$

where *E* is the energy radiated by a black body in watts per square centimetre. Using the accurate pyrometers now available, the value for *K* has been found to be 5.6×10^{-12}.

Recorders.—The advantages of continuous records of furnace temperatures have been widely recognised during the last few years, and in consequence developments in this branch of pyrometry have been extensive. The modern form of the Roberts-Austen photographic recorder, made by the White Instrument Co., is used in many places; but the modern tendency is in favour of inked records, which are always visible, and require no photographic treatment.

In the recorder made by the Foster Instrument Co., for use with thermoelectric or radiation pyrometers, the galvanometer is pivoted horizontally, the pointer being vertical. At the tip of the pointer is placed a capillary tube, carrying an inked wick, so that a mark is made on the chart when the wick is brought into contact by the action of the presser-bar. This bar is actuated by clockwork, and presses the tip of the pointer on to the paper at definite intervals, between which the pointer swings freely under the influence of the pyrometer. The chart is circular in form, and rotates on its axis at a definite rate. The radial lines from the centre to the circumference are divided into degrees of temperature; and hence the condition of the furnace at any given time may be read off. It is a strongly-made and serviceable instrument. The utility of the Thread Recorder, made by the Cambridge

Scientific Instrument Co., has been extended by adapting it for the purpose of obtaining several simultaneous records. Two indicators are fixed side by side, the pointers of which are depressed at intervals on to an inked thread, which touches the chart and makes a mark. A double chart is mounted on a single drum, which rotates by clockwork, and a separate pyrometer may be coupled to each indicator. When four records are required simultaneously, two threads, wetted with inks of different colour, are used; and by an automatic arrangement the pointer may be made to descend on each thread in turn. Two pyrometers are connected to each galvanometer, and are brought into circuit in turn, so that the records of each appear in a different colour; and thus four records in all can be secured on the same chart. It may be used for thermoelectric or radiation pyrometers. The Leeds and Northrup Co., of Philadelphia, have introduced a recorder which is actuated by an electric motor, instead of clockwork, and which may be used for resistance or thermo-electric instruments. A boom from the coil of a galvanometer is placed between a system of levers, and when on either side of the central position it enables the levers to engage and to cause a disk to rotate. The effect of the rotation is to readjust matters so that the boom is restored to the central position. Used with a resistance pyrometer, the moving disk alters the resistance in one arm of a Wheatstone bridge until a balance is obtained, when the boom assumes the central position and the levers fail to engage. When connected to a thermoelectric pyrometer, the movement causes an arm to move over a potentiometer wire (fig. 1), until the E.M.F. due to the pyrometer is counterpoised, when the boom will become central. The movements of the disk are communicated, by suitable mechanism, to a pen moving over a chart. This recorder is much used in the United States, but has not yet been adopted in Britain.

The motor-drive has also been applied in the recorder made by R. W. Paul. A special device is used to ensure a constant speed of rotation in the motor, which, by suitable gearing, actuates the chart and presser-bar. The pointer of the galvanometer is pressed periodically on to an inked ribbon, beneath which is placed a thin metal rod over which the chart passes. The speed of the various movements may be altered by changing the gear. A Unipivot galvanometer is used when records of thermoelectric or radiation pyrometers are being made; and when a resistance pyrometer is employed a Harris indicator is used instead of the galvanometer. Multiple records may be secured with any type of pyrometer; and specially useful features are: (1) The provision of metal-faced joints in the cover, which makes the recorder dust-proof; (2) the construction of the apparatus in separate units, each of which is easily replaceable; and (3) the use of the motor in place of clockwork, which enables a greater power to be used in actuating the various parts.

Messrs. Siemens & Co., who were the first to introduce an ink recorder, have recently introduced several improvements in their instrument. The case is now constructed entirely of metal, jointed so as to be dust-proof. A pivoted galvanometer is used, and the pointer, made of thin metal, is pressed down periodically on to an inked ribbon, beneath which is placed a metal knife-edge over which the chart passes, so that a small dot is made at each contact. The case is made with a sloping front in which a window is inserted, thus enabling a large portion of the record to be seen at a glance. This front is hinged to permit of access to the clockwork, which is made in three separate parts, controlling respectively the forward movement of the chart, the ascent and descent of the presser-bar, and the movements of the rollers on which the record-paper is wound. Robust construction and small size are features of this recorder.

At the present time, when all are in search of methods of adding permanently to our industries, the example furnished by the manufacture of pyrometers may be cited as a useful guide to success in this direction. All the establishments in which pyrometers are made in this country are under the direction of thoroughly skilled scientific men, who are constantly devising new instruments with a view to greater efficiency and a wider field of application. All are in close touch with the National Physical Laboratory, which has proved invaluable to them in regulating the calibration of their instruments, and securing a uniformity which is now comparable to that which exists in thermometers. The result is a thriving and constantly extending industry, not threatened by foreign competition, and not in need of artificial props to ensure its success. The instruments exhibited, all of British manufacture, cannot be surpassed, or probably equalled, by any other country; and are examples of what may be accomplished by the intelligent application of science to industry.

Discussion.

In the course of the discussion, the Chairman (Sir Robert A. Hadfield, F.R.S.) said that human eyes varied, and two observers trying to observe the temperature of the same heated object generally arrived at quite different conclusions. As showing the extremes of temperature which had been measured, it might be mentioned that Professor K. Onnes had been down to within 1½ deg. of the absolute zero; on the other hand, Mr. O. Lummer claimed to have reached as high as 6,090 deg. absolute (about 5,800 deg. C.), by impregnating the carbons of the arc, and working it under high pressure, that artificial temperature of course approximating to that of the sun. Dr. Whipple, acting under strong advice which he put before him, was now in a position to turn out pyrometers for the supply of which we had hitherto been dependent upon the Continent. They were now "made in England." Nearly all the developments of special steel were due to the possibility of now being able to determine temperatures varying from a few degrees to 1,200 deg. C. or more. The manufacture of modern armour, projectiles, guns, material, and so on, was now practically dependent upon accuracy of temperature observation. At certain physical temperatures a difference of even one degree Centigrade would considerably modify the physical qualities of the steel being treated. Ordinary carbon steel of tool-steel grade quenched at 725 deg. C. would bend considerably, and had a Brinell hardness number of 228. Quenched at 735 deg. C., the same material would only bend 1.5 deg., the hardness number being increased to 512. Quenched at 740 deg. C., or only 5 deg. C. higher, the bend was nil, and the hardness number was increased to the high figure of 713. Thus, there was the remarkable fact that by increasing the temperature only 15 deg. C., one had the phenomenon of complete hardening. The small difference of 15 deg. C. (27 deg. F.), within which range hardening or non-hardening results occurred, represented no more than the change in temperature between a spring and a summer day, yet such slight differences in temperature entirely revolutionised the structure of steel. In a difference of only about 4 deg. C., complete revolution took place in the magnetic qualities of iron. For example, the thermo-couple temperature was kept steady for several minutes at 733 deg. C. in one case without alteration in the magnetometer deflection, which differed very little from that at 730 deg. C. The furnace temperature was then raised very slightly, and, *before* the thermo-couple reached 734 deg. C. a rapid fall of magnetisation set in. In other words, that important revolutionary change in iron could only be determined by the aid of very accurate pyrometers. They were not very sure about temperature observations when they got up to 1,400 deg. C. and higher. Molten mild steel had a temperature of about 1,580 deg. C. Couples exposed to high temperatures were liable to become very brittle and, when immersed in fluid steel, disintegrated. In a general way, speaking from many years' experience, the following represented the experience of the laboratories in Sheffield. With reference to the best form of couples, nothing had been found for all-round service to supersede platinum and platinum-rhodium. There were some good base-metal couples, but they were not serviceable for high temperatures. He found it best to use resistance wires of the platinum alloys throughout. The use of those couples was not so expensive as might at first sight seem to be the case, because the scrap platinum from high-temperature work was useful for low-temperature work. With regard to the various forms of pyrometer instruments, platinum resistance pyrometers were too sluggish for quick readings, not suitable for high temperatures, and were costly to repair. It had been found that the thermo-electric type was best. The vital point about these had been to get an instrument of sufficiently high resistance made up of a material which would not vary with fluctuations of atmospheric temperature. High resistance was absolutely necessary to swamp the changes in resistance of the circuit when using different lengths of couple. Makers were now waking up to this, and the Cambridge Scientific Instrument Co., Siemens Bros., and the Beighlee Co. of America, were found to be quite satisfactory in that respect. Carpentier, of Paris, also made an excellent instrument, having 1,000 ohms resistance, entirely of German silver, and giving a scale 13 in. long. It had been found essential for accuracy to keep the instrument in a fixed position and calibrate it *in situ*. With regard to recording pyrometers, there were very few instruments on the market of sufficiently high resistance, and nothing had been found to beat the Roberts-Austen photographic recorder, made by the White Instrument Co., for serviceability. With regard to calibration, he strongly emphasised the desirability of calibrating with standard melting and boiling points, in preference to relying upon the makers' calibration or on standard couples. As an example of the cost of platinum and platinum-rhodium wire as used in modern pyrometers, he might say that his firm, in 1913, spent on platinum and platinum-rhodium wire £370, in 1914, £415, and the expenditure for this year would probably be about £600. They made many thousands of determinations each week. If any one of these were inaccurate it would mean bad work and the loss of hundreds of pounds. That would give some idea of the importance of pyrometer work.

Mr. Charles E. Foster thought the pyrometer-maker was ahead of the furnace-maker in so far as the control of temperature was concerned. The pyrometer-maker could measure to a finer degree of accuracy than the furnace-maker could make a furnace to maintain that temperature. In order to secure a base metal thermo-couple which was going to be stable, a great deal of refinement had to be given to the alloys before they were used. The base metal thermo-couple usually oxidised much faster than the noble metal. In the noble metal the chief danger was contamination either by furnace gases and metal vapours in the furnace gases, or from the alloy (perhaps 10 per cent. iridium with platinum) in the platinum wire. With base metal thermo-couples that difficulty did not arise. Oxidation and the mechanical fracture of the wire appeared to be the usual end of the life of

the base metal thermo-couple, and that, in his experience, generally occurred long before the contamination had reached anything detectable within commercial limits.

Dr. J. A. Harker believed a lot of the difficulty with regard to certain types of pyrometer was not due to inherent lack of homogeneity in the wires themselves, but very often was due to lack of sufficient immersion to give the true temperature of the part which really mattered. With regard to the volatility of metals, supposing a globule of silver was dropped down the porcelain tube of a resistance thermometer, and it was heated for an hour to 700 deg. C., it broke down the whole of the insulation completely.

Mr. Henry C. Jenkins remarked that it was very difficult to make alloys like constantan absolutely uniform. A very small difference in composition would very much alter the E.M.F. obtained from those thermo-couples. The question of the porosity of the sheaths was very important. A little metallic vapour was fatal to any accurate reading.

The Author, in reply, said that, speaking within practical limits, the more fragile the pyrometer, and the less material there was about it, the more accurate it was likely to be, but there were mechanical limitations which had to be provided for. There was no doubt that some of the pyrometers in use were far stronger than was necessary, and the strength was put in at the expense of accuracy. Whether a practical liquid element could be made out for a furnace was a matter which, for the present at any rate, he preferred to leave to the instrument-maker.

BUSINESS NOTES.

Electrolytic Copper in Germany.—It is announced that the Huttenwerke Niederschonweide propose to erect plant in the vicinity of Bitterfeld for the production of electrolytic copper. The energy required is estimated at 2,000,000 KW.-hours per annum, and would be obtained from the Electro Works Co., of Golpa Jessenitz. The carrying out of the scheme would increase to three the number of works turning out electrolytic copper, the two existing being those of the North German Refinery Co. and the Kayser Metal Co.

Private Arrangements. — Venner's Electrical Cooking and Heating Appliances, Ltd., 66 and 68, Wandsworth Road, London, S.W.—In pursuance of the Companies' (Consolidation) Act, a meeting of the creditors of the above was held recently, when the liquidator (Mr. G. E. S. Venner) presented an approximate statement of affairs, which showed liabilities of £1,703 6s. 8d. The assets consisted of book debts £167, plant and fixtures £500, estimated to realise £300, office furniture £136, stock in trade £819 and cash in hand £12, making total assets of £1,434, or a deficiency of £269. It was reported that the company was registered in April, 1914, with a nominal capital of £100,000. The company was formed to take over certain patents, and the vendor (Mr. Venner) received as consideration shares of the face value of £83,500. A sum of £3,806 was also subscribed in cash for shares. It was pointed out that the company had carried out certain experimental work and had been placed on a satisfactory basis. Negotiations were in progress with a view to a reorganisation and the sale of the patents and assets to a new company. After discussing the position, it was decided that the meeting should be adjourned in order that arrangements for the sale of the patents and assets might be carried through. It was stated that the sale should provide sufficient to discharge the creditors' claims in full.

Harold Bourne (trading as H. G. Andrews & Co.), electrical engineers, 16, Royal Arcade, Boscombe, and The Wharf, High Street, Swanage.—The creditors interested herein were called together recently, when a statement of affairs was presented which showed liabilities of £1,263. The indebtedness to the trade was £385, Mr. A. Bourne was shown as a cash creditor for £400, and there was an overdraft at the bank of £478. The assets were estimated to realise £295, less £44 for preferential claims, leaving net assets of £250, or a deficiency of £1,013. No offer was made by the debtor, and it was decided that Mr. H. W. Buckingham, of Messrs. Knapmann & Buckingham, Rood Lane, E.C., should be appointed trustee of the estate, with a committee of three of the creditors. It was stated that an attempt would be made to dispose of the stock by private treaty, failing which a public auction would be held.

Trade Announcements.—Mr. Harry Nance, Dragon Buildings, Cardiff, is now representing the Premier Accumulator Co., Ltd., for South Wales and Monmouthshire, his arrangements with Messrs. Pritchetts & Gold, Ltd., having been determined on July 20th last, this being necessary in connection with the amalgamation of the latter company with the E.P.S. Co.

The agency for the British Isles for the electric vehicles (including the "Ward Special," recently described in our pages) built by the Ward Motor Vehicle Co., of Mount Vernon, N.Y., has been taken up by Mr. Dermot Mooney, 28A, Gillingham Street, Victoria, S.W.

The agency for the "Century" single-phase motors has been acquired by the Swedish General Electric, Ltd., Norfolk House, Cannon Street, E.C., and the London stock of "Century" motors is now under their control. This department of their business is being carried on by Mr. R. A. Marples, who for many years has represented the Century Co. in the United Kingdom.

For Sale.—The Visiting Committee of the County Asylum, Upton, Chester, have for disposal by tender three 35-KW. steam-driven dynamos, main switchboard and feeders, also one vertical engine. Particulars are given in our advertisement pages.

Deeds of Assignment.—George Braulik, 8, Lambeth Hill, and Maiden Lane, London, E.C.—In the matter of a deed of assignment dated June 3rd, 1914, and registered on June 10th, 1914, the statement of trustee's receipts and payments from December 4th, 1914, to June 30th, 1915, has been issued. The total payments into the London City and Midland Bank to June 30th, 1915, were £7,472 15s. 6d., and the total payments to that date, £7,397 4s. 5d. The amounts of liabilities and assets at the date of the execution of the deed as estimated by the debtor were £11,914 2s. 1d. and £11,533 15s. 10d. The terms of the deed of composition have now been fully carried out and the estate has been reassigned to Mr. Braulik.

H. J. Booker, electrical engineer, 51, Tothill Street, Westminster, S.W.—Particulars of claims must be sent by August 25th, to the Trustee, Mr. G. E. Corfield, Balfour House, Finsbury Pavement, E.C.

Liquidation. — Prested Miners' Gas-Indicating Electric Lamp Co., Ltd., Upper Holloway, London.—Liquidator released July 31st, 1915.

Motor Catalogue. — Langdon-Davies Motor Co., 110, Cannon Street, London, E.C.—New 20 pp. price list tabulating in detail particulars, prices, weights, dimensions and code words of electric motors, squirrel-cage and slip-ring types, single-phase 40 to 125 periods, and polyphase, 25 and 50 periods.

Book Notice. — "Handbook of Patent Law." By W. P. Thompson. London: Stevens & Sons. Price 2s. 6d. net.

LIGHTING and POWER NOTES.

Abingdon.—Extension of Area. — The Abingdon Electric Light Co. is applying to the B. of T. for a prov. order to supply current to the outlying district. The R.D.C. has asked the company where the overhead system is to be used and also for the scale of charges.

Barking.—Plant Extensions.—The T.C. last week considered the report of the electrical engineer on the necessity for new plant and extensions at the electricity works. Some months ago the Council's application to the L.G.B. for sanction to a loan of £18,000 for extensions was returned for amendment, the Board suggesting certain omissions. It was stated that in order to meet the demand for power during the next few months, and to guarantee a continuous supply during the coming winter, the installation of new plant was necessary, and it would also reduce the generation costs. The capital expended on the undertaking was over £60,000, but had been reduced by repayments to £30,000. The total loss on the undertaking to 1914 was about £9,000. The report was adopted, and the Council accepted tenders for new plant amounting to £13,536; it was decided to submit a revised estimate to the L.G.B. based on the tenders accepted, and to include £1,600 for buildings.

Belfast.—At the quarterly meeting of the City Council a lengthy discussion took place in regard to the question of reorganising the electric supply department. Apparently a special sub-committee has had the matter under consideration, and has decided that such reorganisation can only be effected by the chief engineer of the undertaking, and as the various schemes submitted by him have not been adopted, the sub-committee reluctantly concluded that he should be given an opportunity of resigning; it was admitted that this was not the view of the majority of the Tramway and Electricity Committee. The Council was asked to come to a decision on this matter, but following a discussion, an amendment was moved, "That all minutes relating to the reorganisation of the electricity undertaking be deleted, that it be an intimation to the Committee that the chief electrical engineer is subject to the supervision of the Committee, who have full control of the organisation and administration of the electricity department, until the Council decides otherwise," and carried by 25 votes to 19. In the course of debate, Ald. Sir Robert Anderson said that during seven years as chairman of the Electricity Committee, he never heard a single accusation brought against Mr. Bloxam (the engineer) for incompetence or anything else; he had been persecuted by every possible means, but he never heard him utter a word against his persecutors. It was further stated that Mr. Bloxam's scheme for reconstruction had never once been discussed.

Blackburn.—The T.C. has been informed that the B. of T. has consented to land at Whitebirk being used for electricity works.

Bootle.—Year's Working.—The report of Mr. T. D. Clothier, the borough electrical engineer, on the working of the electricity undertaking for the year ended March 31st last, shows that 5,173,000 units were sold, as compared with 4,683,000 in the previous year, the increase being due to increased power and private lighting sales. The maximum load was 2,480 KW.; the nominal generating plant capacity is given as 4,450 KW., but this,

it is noted, includes both the new Marsh Lane station and the old Pine Grove station, which latter is, to some extent, regarded as a stand-by. The total connections to the system, excluding tramways, amounts to 8,015 KW. The new works at Marsh Lane have supplied the bulk of the output during the year, at a generating cost of '44d. per unit, as against '54d., the lowest cost recorded at Pine Grove station; had conditions as regards coal been normal, the cost per unit would have been reduced to '35d. The income for the year was £29,494, and the gross profit £13,488 (as against £11,186 in 1914), and, after meeting financial charges, the net profit was £3,014 (as against £1 340 in 1914). Of this surplus, £1,514 was placed to reserve (the fund standing at £3,556); £246 was placed to renewals (the fund standing at £9,975), and £1,500 was given in aid of the rates. The report gives tabular statistics of the Bootle Street lighting, from which it appears that there are 395 electric lamps of 70,726 C.P. in use in main streets, and 39 such lamps in passages. The candle-power shows a considerable decrease (39,000) compared with the previous year, due to war conditions. An agreement has been made to supply the Litherland Council after the war, and an interconnection with the Liverpool District Lighting Co., for supply to the Mersey Dock and Harbour Board, has been made.

Bradford-on-Avon.—The U.D.C. has consented to an overhead E.L. cable being used by Messrs. Spencer, Moulton & Co., to convey current to Abbey Mills.

Bredbury and Romiley.—PROV. ORDER.—The Stockport T.C. intends to apply for a prov. order to authorise it to supply electricity within the urban district of Bredbury and Romiley. The D.C. has decided to ask Stockport for a full statement of its proposals.

Bridlington.—L.G.B. INQUIRY.—The adjourned L.G.B. inquiry into the application of the T.C. for sanction to appropriate a site adjoining the electricity works for the erection of a refuse destructor, was held on August 4th. Objection was taken to the site, the opponents including the East Riding of Yorks. County Council and Education Authority. The T.C. had previously declined to select any alternative site on account of loss of energy in transmission and the increased capital outlay.

Canada.—Owing to the rapid increase in the consumption of hydro-electric power in the western portion of Ontario, the Hydro-Electric Commission has notified the Ontario Power Co. to prepare for furnishing the last 10,000-H.P. consignment of the 100,000 H.P. contracted for. The total revenue from the municipalities, railways and large users on the Niagara circuit of the hydro-electric system for the six months ended May 1st was $710,324.95; after providing $303,000 for the cost of power, $49,000 for maintenance, $155,000 for interest, $30,000 for operation, and $156,000 for engineering and construction, the sum of $69,808.37 has been applied to the sinking fund, and $50,210.35 to the depreciation and reserve account. In order to provide for future demands the engineering staff of the Commission is investigating the development at Niagara of a hydro-electric plant of its own. It is understood that the plans are being prepared for a 250,000-H.P. development, and it is expected that the Commission will shortly be able to announce something definite relative to this big undertaking.—*Canadian Engineer.*

Chester-le-Street.—STREET LIGHTING.—The U.D.C. proposes, when the present gas contract expires next year, to invite tenders for public lighting by electricity.

Chester.—YEAR'S WORKING.—With reference to our "Note" under this heading last week, we may add that the total output sold by the electricity undertaking was 2,535,600 units, as compared with 2,531,709 in the previous year, the total costs being '825d. against '839d. per unit, and the fuel cost '211d. as against '281d. per unit, the actual total cost of coal used being substantially less than in the previous year, owing to the use made of hydro-electric energy. The net profit of £3,194, together with the balance brought forward, amounted to £10,163, from which various allocations were made, as previously stated, including £6,933 to capital account, and a working balance of £1,358 was carried forward. The total of revenue contributions to capital, to date, amounts to £16,792, and the department also has a reserve fund of nearly £7,000. The total loans outstanding amount to £95,239, and the total of debt extinguished and revenue contributions to capital amount to £64,494.

Chesterfield.—PROPOSED PLANT EXTENSIONS.—The Electrical Committee has recommended the Town Council to approve of the plan and estimates for a scheme of extensions to meet the requirements for the coming winter, at a cost of £15,200. Subject to satisfactory financial arrangements being made, tenders will be invited for a 2,000-KW. turbo-alternator, condensing and air-filtering apparatus, switchboard and cables, a water-cooling tank, an overhead travelling crane, two superheaters and two mechanical stokers.

The Corporation has increased the charges for electricity for private lighting and power purposes by 12½ per cent., except to consumers under special contract.—*Sheffield Daily Telegraph.*

China.—The China Lighting and Power Co. is building a new power station to contain generating plant of sufficient capacity to deal with considerable increases in load in the area at Kowloon which is supplied by it. The plant, which has been constructed by the British Thomson-Houston Co., consists of two 937-K.V.A. high-pressure B.T.H. three-phase, 60-cycle, 2,200-volt Curtis turbo-alternators with direct-coupled exciters, designed to run at 3,600 R.P.M. These sets will be supplied with steam at 180 lb. gauge pressure, superheated 160° F. The condensing plant will be of the surface type, and will be equipped with rotary type motor-driven pumps throughout. The cooling water for the condensers will be drawn from the sea through a duplicate set of suction mains. In connection with the turbo-alternators, suitable air filters will be supplied. A Lea recorder with integrating attachment will be installed. For controlling the output and distribution from these turbines a nine panel white marble switchboard will be provided, fitted with all the usual operating gear and instruments; the whole of the switchgear will be fitted with duplicate bus-bars to facilitate handling the loads. A B.T.H. Tirrill regulator will be included in this equipment.

The B.T.H Co. is also supplying the equipment for the Hong-Kong and Whampoa Docks. This will consist of two 350-K.V.A., 250-volt, 900 R.P.M., six-phase, 60-cycle rotary converters. With these are being supplied the necessary transformers and control gear, the latter comprising in each case one high-tension alternating-current panel, one low-tension alternating-current panel, and one continuous-current panel. The B.T.H. rotary converters are equipped with self-synchronising starting motors.—*Eastern Engineering.*

Chippenham.—STREET LIGHTING.—The T.C. has approved of the report recommending that electricity for public lighting be adopted for the recently-added area of the borough.—*Western Daily Press.*

Continental.—RUSSIA.—The Governor of Kieff has informed the local Council that the Minister of Trade and Industry has authorised the Kieff Government to remit 32,000 fr. to Paris for the acquisition of electric meters in connection with the electric concern recently sequestrated, and also to send 55,000 fr. to Switzerland for the purpose of buying transformers. The management of the Kieff Electric Co. has notified the town Government that in view of the difficulty in obtaining coal it will be necessary to use liquid fuel. The management has ordered 600,000 poods of mazout, and is asking for the requisite wagons to bring the fuel over from Ekaterinodar and Baku. It is said that the Government of the town proposes to organise a transport of petroleum in hermetically sealed casks or barrels on horse wagons.

Crewe.—The B. of T. proposes to make an order authorising the T.C. to supply electricity to Manor House, Berkeley Towers and the Oaklands, premises situate outside the borough boundary.

Darlington.—LOAN SANCTION.—The T.C. has received L.G.B. sanction to a loan of £26,100 for additional plant, &c., needed to supply current to the North-Eastern Railway and other works. The total loan applied for was £34,950.

Dartford.—INCREASED PRICES.—The U.D.C. has decided to advance the charges for current as follows as from Michaelmas:—Ordinary lighting, 1d. per unit; long-hour lighting, ½d. per unit; power, ½d. per unit. The charges will be readjusted as soon as coal can be purchased at or near the rates in force before the war.

Dublin.—The report of the Electricity Committee for the quarter ended June 30th shows a credit balance on capital account for loans of £40,084. For short extensions, house services, meters, &c., £9,500 was available, which would carry them to the end of the year. Until a further loan can be raised no connections will be made except on a guarantee of consumption of £6 a year, and mains will only be extended on very exceptional circumstances.

Hereford.—PRICE INCREASE.—The T.C. has increased the price of current supplied to the waterworks department by 10 per cent., as from June 24th.

Heston and Isleworth.—YEAR'S WORKING.—For the year ended March 31st last there was a total income of £10,494 on the undertaking, an increase of £238 over the previous year. The total working expenses amounted to £5,453, an increase of £484, leaving a gross profit of £5,041. After paying interest and loan charges amounting to £4,651, there was a net surplus on the year's working of £390. By debiting the revenue account with the balance of £1,549, cost of consumers' "free wiring," this surplus is converted into a technical deficiency of £1,190. This is accounted for by the fact that early in the year it was decided to place all "free wired" consumers on the same terms as ordinary consumers, and to discontinue the practice of carrying out repairs to all "free wired" installations. In effect it means that this year the Electricity Committee repays the Council as much of the borrowed money as it can—represented by its credit balances of the last few years—and carrying forward the difference to a future occasion. 1,509,227 units were generated during the year, compared with 1,407,351 for the previous 12 months, an increase of a little over 100,000 units.

Holywell.—WORKHOUSE LIGHTING.—The B. of G. has decided to have inquiries made as to the cost of an E.L. installation at the workhouse laundry, power to be derived from the electric plant at the new infirmary.

Ilkley.—E.L. Scheme Inaugurated.—On Monday last the Council's new electricity works were opened by Dr. Bates; supply is given in Ilkley and Middleton. The scheme has involved an outlay of £21,000; the plant, which includes two generators of 160 KW. and a large storage battery, is to be duplicated immediately. Some four miles of feeder cables and 15 miles of distributing cables have already been laid, and there are over 50 consumers on the mains. It is hoped that satisfactory arrangements will be made with several of the large local hydros to take supplies of current and to eventually supply outside townships. Dr. Bates, who started the plant, was presented with a gold key by Mr. George Wilkinson, consulting engineer to the scheme, on behalf of the contractors.

India.—Messrs. Walker, Sons & Co., Colombo, Ceylon, have submitted their report regarding a proposed electric lighting scheme for Ootacamund, in the Madras Presidency. The report recommends the use of the Kunda River and Falls, and the installation of the three-phase alternating-current system, with overhead transmission lines to a central sub station in Ootacamund. In the latter there would be transformers for the street lighting and for local house lighting. The scheme is estimated to cost Rs. 2,10,000, the annual maintenance charges at Rs. 37,000, while the income is placed at Rs. 52,000.—*Indian Engineering.*

Leyton.—L.G.B. Inquiry.—An inquiry into the Council's application for sanction to borrow £17,158 for generating plant, and £1,000 for mains, was held by the L.G.B. on the 30th ult. Of the last-mentioned sum £500 had been spent, the balance being required principally for extensions in connection with Government work. The Inspector expressed the opinion that the Board might grant the £500 expended, although he doubted the granting of the other £500 in prospect. With regard to the main application, it was pointed out that the Council did not press for an early sanction, but wished to be prepared for possible contingencies.—*Walthamstow Guardian.*

Lincoln.—The T.C. has decided to arrange terms, on a sliding scale, for a supply of current for power to Messrs. Foster and Co., Ltd., engineers, on a five years' agreement.

Lytham.—Proposed Loan.—The U.D.C. has instructed the electrical engineer to prepare the necessary plans, &c., to enable an application to be made to the L.G.B. for sanction to a loan for the purposes of electric lighting.

Manchester.—A notice of motion that a special committee should be appointed to inquire into the working and the policy of the Corporation electricity department should have been dealt with at a meeting of the City Council on the 4th inst., but owing to lack of time the matter was adjourned for a month.

Marsden.—E.L. Proposals.—The U.D.C. has decided not to entertain the proposal of the Huddersfield Corporation to supply electricity to the district and apply for a provisional order therefor.

Nelson.—Sewage Works Motors.—The T.C. has approved the decision of the Sewage and Streets Sub-Committee to install electric motors for driving the machinery at the sewage works in preference to gas engines. An effort was made to refer the matter back last week, on the ground that a quarter of a mile of gas mains which had been laid to the works would practically have to be scrapped if electricity were adopted, but the recommendation was approved, the chairman of the Committee stating that it was satisfied it could economise as well as improve in efficiency by using electricity.

Rochdale.—A free supply of electricity has been granted to the Y.M.C.A. Soldiers' Institute; the Electricity Committee has also agreed that for the present no charge shall be made for the current supplied to the Ambulance Drill Hall Military Hospital.

Coal Supply.—With a view to considering whether any benefit may be obtained by a readjustment of coal contracts, the town clerk has been instructed to prepare a report on the new Coal Act and its probable effect on the contracts of the Electricity and Gas Committee.

St. Annes.—The output of electricity sold during June was 68,136 units, against 72,486 for June last year; the chief reduction is on the tramway section. From April 1st to the end of June, however, the aggregate sale was 241,843 units, against 225,756 last year.

St. Helens.—Proposed Plant Extensions.—Subject to L.G.B. approval, the T.C. proposes to spend £15,000 on electricity extensions.

Shanklin.—Street Lighting.—The Isle of Wight E.L. Co. has declined to accept the proposal of the U.D.C. that the allowance on the charges for public lighting for the quarter ending March 21st (owing to restricted lighting) should be one-half of the contract price, and has offered to submit the matter to arbitration. The company had offered a rebate of £50, and to make a rebate for the June quarter based upon the number of units of current not supplied. The Council has decided to take no further steps at present, but to abide by the offer already made.

Stockton-on-Tees.—The T.C. has decided that it is not at present advisable to make any alteration in the existing prices for current.

Torquay.—Proposed Loans.—The L.G.B. has informed the T.C. that it is prepared to sanction loans of £1,577 and £3,518 for liabilities actually incurred, but it proposes to defer the issue of its consent until it has been decided what other sums could be included.

Turton.—Street Lighting.—The U.D.C. has decided that the electric street lamps be reduced from 100 C.P. to 50 C.P. during the ensuing season.

Waterford.—E.L. Scheme.—In reference to the application of the Corporation for sanction to a loan of £30,000 for an electric lighting scheme, the L.G.B. states that the scheme submitted may, from an engineering point of view, be regarded as satisfactory, but having regard to the present restrictions on borrowing by local authorities, the matter is one which must be postponed.—*Freeman's Journal.*

Wednesbury.—Plant Extension, &c.—The accounts of the electricity undertaking for the year ended March 31st show a loss of £116. The Electricity Committee recommends the purchase of additional plant for the King's Hill sub-station, at a cost of £1,580, also an expenditure of £420 for mains, and an application is to be made to the L.G.B. for sanction to a loan of £2,000. The Committee also recommends an additional expenditure of £815 on mains extension at King's Hill.—*Birmingham Daily Post.*

Wimbledon.—Year's Working.—During the year ended March 31st last, the electricity undertaking sold 3,569,217 units, as compared with 3,367,517 units in the previous year. The output sold included 1,369,382 units for power and lighting. The consumers numbered 7,041 (1,155 being supplied on the "fixed price light" system), and the total connected load was 9,850 KW.; the generating plant capacity was 4,825 KW., and the maximum load 2,120 KW., this latter being slightly less than in the previous year. The total revenue was £38,668, and the gross profit £19,608; the net profit carried forward was £2,184. The balance of the suspense account carried forward amounts to £7,849, while the reserve fund stands at £14,906.

We note that in Wimbledon there are 1,155 consumers connected on the "fixed price light" system, which was referred to in our issue of May 15th, 1914; these are practically all very small consumers, and their connected load is 138 KW., while the revenue derived from them is nearly £7 per connected KW., as against only £3·3 per KW. connected from ordinary private lamps, motors, radiators, &c., and about £4 per KW. of total connected load including public lighting. These figures are evidence of the possibilities of the small consumer, if suitable means are adopted for supplying this class of load.

Wolverhampton.—Year's Working.—The accounts of the Corporation electricity undertaking for the year ended March 31st last show a gross profit of £28,631, as compared with £27,436 in the previous year; the net profit was £7,444, as compared with £8,676; £2,215 has been transferred to the relief of rates, and £5,229 to the reserve fund. The total income shows an increase of £1,862. The number of units sold was 13,126,271, an increase of 112,357 over the previous year. During the year 981 H.P. in additional motors were added, the total H.P. of motors now connected being 9,745, while in connection with heating and cooking, apparatus absorbing 980 H.P. was connected. The total cost of production per unit sold was ·551d., coal costing ·220d. The maximum load was 6,260 KW., and the connected load about 14,000 KW. The balance of the reserve fund stands at £17,806.

TRAMWAY and RAILWAY NOTES.

Australia.—The construction of the Sydney City Railway is to be commenced as soon as the scheme has received the sanction of Parliament. Electric traction will be used, and it is intended to connect with North Sydney and the Nelson's Point Railway.

The estimated cost of wiring from the present Nelson's Point terminus to Hornsby is £108,000; in addition, further expenditure will be necessary to provide rolling stock, transmission lines and sub-stations. The question of funds for the electrification of the Nelson's Point-Hornsby Railway is to be considered in connection with the next loan estimates.—*Sydney Daily Telegraph.*

The Victorian Railway Commissioners have stated officially that they have no intention at present to supply energy from the Newport power house for commercial purposes. The power house is designed as part of the suburban railway electrification scheme for the needs of the railways only, and it is not considered there will be any surplus available for commercial purposes.—*Melbourne Age.*

Burnley.—The Tramways Committee has decided that all persons engaged upon the manufacture of munitions be allowed the privilege of travelling on the local cars by workmen's discount tickets at any time during the week.

(*Continued on page* 211.)

ROBERT HAMMOND.

By the death of Mr. Robert Hammond, on August 5th, the electrical engineering industry has been deprived of one of its most popular and influential members. Mr. Hammond possessed a personality which rendered him unique amongst his fellows—bluff, hearty, sympathetic, and courteous, with a keen sense of humour and a ready wit; he was a fluent speaker, with a powerful voice, and his speeches always commanded the interest and attention of his audience. He took a prominent part in public affairs, particularly in connection with the Institution of Electrical Engineers, of which he was Honorary Treasurer for nearly 13 years, and his administration of the funds of the Institution was marked by sound finance and commercial acumen of the highest order. Born in 1850 at Waltham Cross, he became an iron-master and established works at Middlesbrough, but on the introduction of electric lighting he entered this new field with characteristic energy, and was the first to obtain a concession from the Anglo-American Brush Co. for the exploitation of their system in this country. His first essay in electric lighting was carried out in 1880 at the iron-works of Messrs. Bernhard Samuelson & Co., of Middlesbrough, where he installed a number of arc lamps near the blast furnaces; in the following year he lighted the rail-straightening department of Messrs. Bolckow, Vaughan and Co., entirely at his own risk, to enable a night shift to be run, and this enterprise was so successful that many other firms immediately invited him to install arc lamps in their works.

Robert Hammond, M.Inst.C.E., M.I.E.E, M.I.Mech.E.

In October, 1881, Mr. Hammond laid down what he claimed was the first public lighting station in this country where arc and incandescent lamps were fed from a high-pressure circuit, using a Brush dynamo which gave 10 amperes at 2,000 volts. This was at Chesterfield. In the same year he gratuitously installed electric lamps in the streets of York, during the visit of the British Association to the city, and a public lighting scheme was put in hand at Cockermouth.

Mr. Hammond also lighted an exhibition at Brighton in the winter of 1881 with Brush arc lamps, under the charge of Mr. Arthur Wright, and at the request of certain local tradesmen he subsequently installed the plant on a permanent basis and commenced the public supply of electricity in February, 1882; this undertaking shares with a station established by the Edison Co. at the Holborn Viaduct the honour of being the first of its kind, supplying electricity for arc and incandescent lighting to private consumers, but, unlike the Holborn venture, which expired after a brief and troubled existence, it continued in operation for 13 years, and eventually was purchased by the Brighton Corporation in 1894. It is interesting to note that the supply was carried on for some years with bare overhead wires at 2,000 volts; incandescent lamps were run in parallel-series, as at Chesterfield.

Mr. Hammond was also responsible for the electricity works which were inaugurated at Eastbourne and Hastings in 1882; underground mains were used at Eastbourne under an agreement with the Corporation, which, as a matter of fact, was entirely *ultra vires*; in 1890, however, the lighting company obtained a provisional order. Mr. H. M. Sayers was the first engineer at Eastbourne, and later became chief engineer of the works laid down for an English company by Mr. Hammond, at Madrid. The generating plant consisted, as usual, of Brush arc dynamos, driven by semi-portable engines; but in 1886 the alternating-current system was introduced, with Lowrie-Hall alternators and transformers, the latter being made at the Eastbourne works, and the success of this plan put an end to the series-parallel grouping system. Both the Eastbourne and the Hastings undertakings were eventually purchased by the local authorities.

From the foregoing it will be seen that Mr. Hammond occupied a prominent position in the front rank of pioneers of the electrical engineering industry; moreover, he claimed to be the author of the first book on the electric lighting of private houses, and the first in Europe to light his own house with electricity throughout. His activities, however, were not confined to innovation. Commencing practice as a consulting engineer, he was responsible for the design and erection of a large number of electricity works in the United Kingdom, of which the principal were those at Leeds, Hackney, and Dublin, as well as several foreign undertakings. He also acted as consulting engineer for a number of electrical tramways. Most of his work, which involved the expenditure of several millions sterling, was carried out in conjunction with municipalities, and he was credited with the possession of persuasive faculties which enabled him to convince the most sceptical town councillor of the soundness of his proposals. Another *rôle*

in which he was particularly successful was that of Parliamentary expert witness, in which capacity he took a large share in the various proposals for the improvement of the electricity supply to London; and as expert in legal actions and arbitrations he undertook heavy responsibilities, in some important cases himself acting as arbitrator.

During the earlier years of electric lighting he paid many visits to the United States for the purpose of studying electrical developments there, and he travelled extensively also on the Continent and in South Africa. In 1905 he read an important paper on the distribution of electrical energy on the Rand, at the meeting of the British Association at Johannesburg; recognising the immense possibilities of the district, he outlined a scheme for supply on an enormous scale at 0·6d. per unit, and in the following year, in a communication to us, he formulated a trenchant criticism of the proposal to utilise the power of the Victoria Falls on the Zambesi River, 700 miles away. It is interesting to note that the hydraulic scheme was abandoned, and a huge power station was erected at Vereeniging, the site which he put forward in his B.A. paper as the most suitable for supplying the Rand.

In 1902 Mr. Hammond took his son, Mr. R. W. Hammond (who is now on active service as Captain in the Public School Battalion of the Royal Fusiliers) into partnership, and the style of the firm became "Robert Hammond and Son."

Perceiving the necessity of making provision for the training of students in electrical engineering, as long ago as 1882 Mr. Hammond established a school called the "Hammond Electrical Engineering College"; in 1889 the functions of this institution were taken over by the Electrical Standardising, Testing and Training Institution ("Faraday House"), in the management of which from the first he played an important part. He was a Member of the Institutions of Civil, Mechanical, and Electrical Engineers, as well as of the Association of Consulting Engineers and of the South African Institution of Engineers. An ardent politician, he was a member of the leading Liberal clubs, and of the Whitehall Club, which is the home of many electrical engineers. He was the author of many papers and addresses before the Institution of Electrical Engineers and other societies, and was an enthusiastic statistician; in pursuit of this hobby, as "Chesterfield Junior" he conducted in *Lightning* a detailed analysis of the costs of production of electricity in British works. His paper on the "Cost of Generation and Distribution of Electrical Energy," read in 1898 before the I.E.E., contained an enormous mass of data, which he classified and discussed in masterly style. His stalwart presence and his rugged eloquence will be sorely missed at the meetings of the Institution, and his innumerable friends will long mourn the loss of his hearty good-fellowship and cheery greeting.

The funeral took place on Monday last, at Golder's Green Crematorium, in the presence of relatives and a large gathering of friends, amongst whom were noted Sir John Snell, Dr. Alex. Russell, and Messrs. J. H. Rider, W. M. Mordey, Spencer Hawes, John May, F. Ince, H. M. Sayers, A. H. Preece, Frank Gill, J. E. Kingsbury, A. A. Campbell-Swinton, A. M. Sillar, Alex. Siemens, H. W. Wyld, Sydney Sharp, A. W. Heaviside, W. P. Nicholas, and Wm. Soper.

A JAPANESE RAILWAY ELECTRIFICATION.

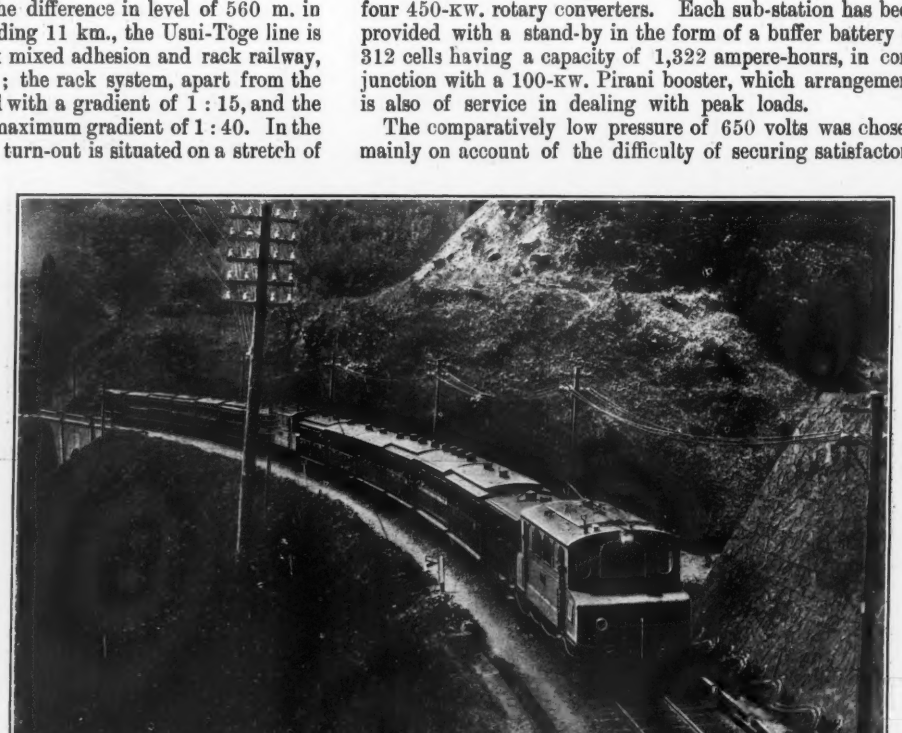
An important step towards the electrification of Japanese trunk lines was taken with the adoption of electric operation on the Usui-Toge Railway, a line crossing the chain of mountains some 120 km. to the north-west of the metropolis and passing through 26 tunnels.

In order to overcome the difference in level of 560 m. in a track length not exceeding 11 km., the Usui-Toge line is designed as a single-track mixed adhesion and rack railway, on the Abt rack principle; the rack system, apart from the approaches, is constructed with a gradient of 1 : 15, and the adhesion sections with a maximum gradient of 1 : 40. In the centre of the line the only turn-out is situated on a stretch of level ground 125 m. in length, confined between two rocky ridges. The maximum train length is determined by the length of this turn-out, which has no continuous rack. The line is of the standard Japanese gauge of 3½ ft., with rails 30 kg. per m., and the iron sleepers, to which the triple-bar rack is also fixed, are placed 80 cm. apart and anchored.

The electrical energy for the whole plant is obtained from a power station specially erected in the neighbourhood of Yokogawa. Three vertical 1,000-kw. Curtis turbo-generators built by the G.E. Co. (New York) have been installed and supply current at 6,600 volts and 50 cycles, while exciting current is provided by two 75-kw. 125-v. exciters, direct coupled to vertical steam engines.

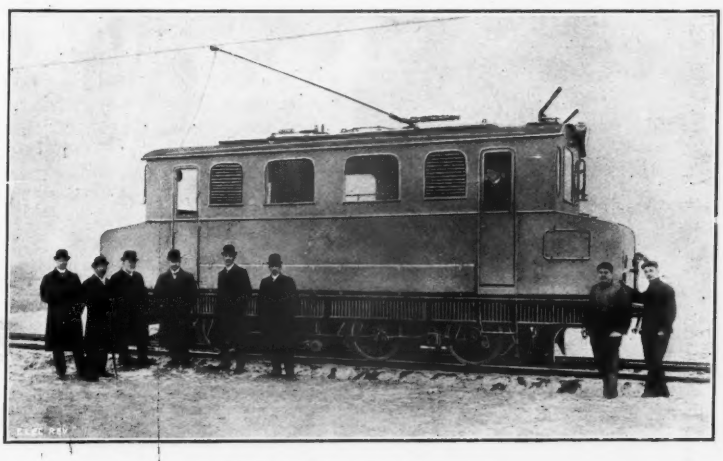
Steam is supplied by eight water-tube boilers, fitted with superheaters and automatic stokers. The whole boiler plant was constructed in Japan, and local coal is used. The current generated at the power house is led to two sub-stations through underground armoured cables, and stepped down to 240 volts by transformers, to be converted to direct current at a pressure of 650 volts, by means of four 450-kw. rotary converters. Each sub-station has been provided with a stand-by in the form of a buffer battery of 312 cells having a capacity of 1,322 ampere-hours, in conjunction with a 100-kw. Pirani booster, which arrangement is also of service in dealing with peak loads.

The comparatively low pressure of 650 volts was chosen mainly on account of the difficulty of securing satisfactory insulation in the narrow tunnels, which made the adoption of a h.t. overhead line impossible. On the other hand, with the outputs and currents in question only the third rail system could be considered for the rack section of the line.



Electric Train, Usui-Toge Railway, Japan.

On the side tracks, at the stations of Yokogawa and Karuizawa, where the installation of a third rail would have been difficult owing to the intricacy of the points and crossings, and no heavy currents have to be transmitted, the current is collected from an overhead line having a section of 100 sq. mm. The form of suspension adopted is the well-known catenary system, a special messenger cable being employed. The overhead line is fed by four insulated feeder cables connecting each converter station with the line, which is carried on wooden masts in the open and on insulators in the tunnels; the current is returned through the rails and special cables laid beside the track.



General View of Locomotive.

The electric locomotives are designed on what is known as the mixed system, *i.e.*, with separate drives for adhesion and rack operation respectively, and will haul a train of 90 tons, or, when two locomotives are used, a double train of 180 tons, on a gradient of 67 per cent., at a speed of about 16 km. per hour.

The drive is effected by elevated motors and parallel-crank mechanism, this arrangement being entailed by the considerable output, as well as by the design of the locomotives for rack running. The weight of the locomotive (42,000 kg.) is distributed nearly uniformly over three adhesion driving axles; the output of each motor is 350 H.P., at 650 R.P.M.

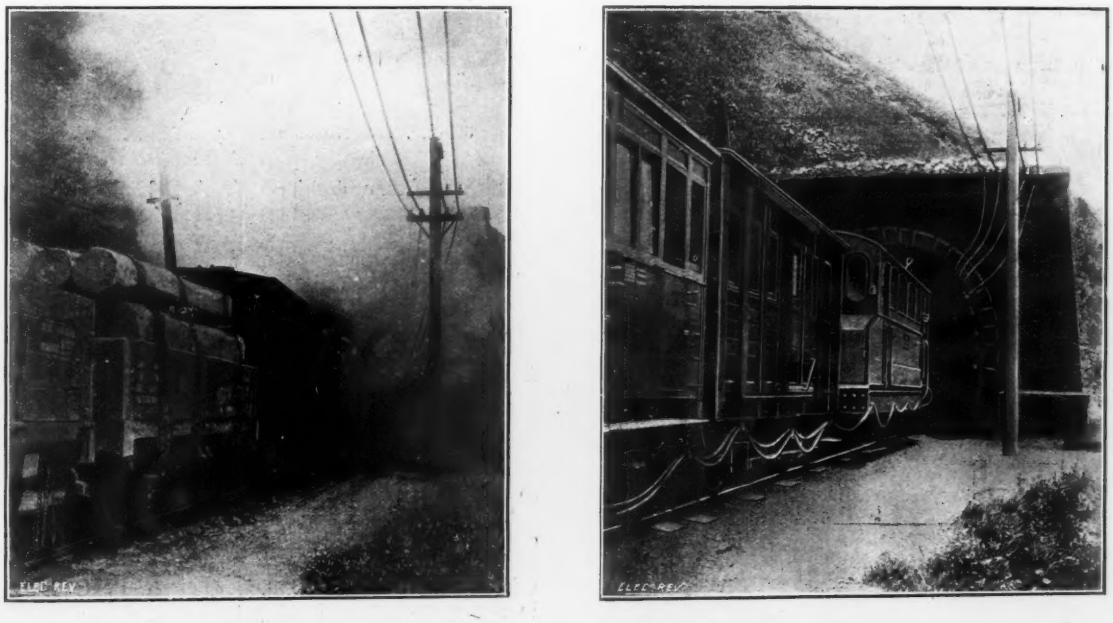
The motor intended for adhesion operation is firmly fitted into the spring-suspended main frame of the locomotive, and works through a cog-wheel transmission of 1 : 6·4 on to the intermediate shaft, and thence through a parallel-crank mechanism on a loose shaft firmly mounted in resilient frames, whence the last drive is effected by means of connecting rods.

The two driving pinions are mounted on the inside frame, which is firmly mounted on two axles. This arrangement allows carrying springs of sufficient resilience to be used, thus protecting the sensitive electric apparatus, which would otherwise be exposed to heavy shocks.

The inside frame also carries the driving motor for the rack gear, which is partly spring supported. The motor is free to rotate in a cast-steel trestle on the inside frame, and, like the adhesion motor, works on to toothed wheel gearing, and thence through a connecting rod directly on to a driving pinion axle. The two axles are connected together by coupling rods. The cranks are set at an angle of 90°, as in the case of the adhesion drive. Both motors are subdivided, the upper half, like the armature, being lifted and fitted by means of a crane.

A friction clutch, which slips on a given torque being exceeded, is fitted between the armature shaft and the pinion and protects the driving gear, which is rigidly coupled by the rack and the driving pinions, in the case of sudden jerks, short-circuits, &c.

The current is collected from the underside of the third rail by sliding shoes, fixed at the front and rear of the locomotive. Two trolley collectors (one for each direction of travelling) are provided on the roof of the the locomotive, for the overhead line of the side tracks.



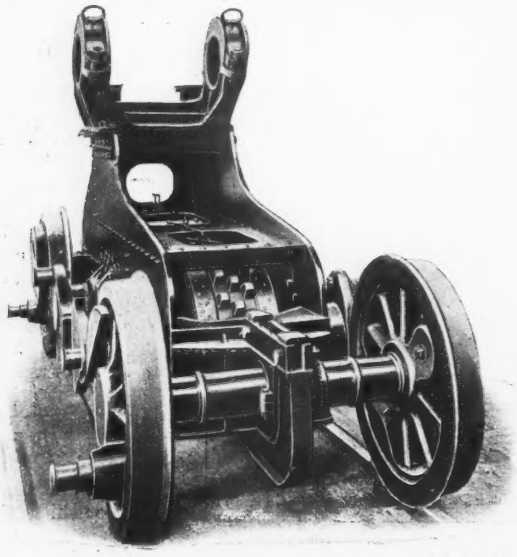
Views showing Tunnel Entrance before and after Electrification.

The motors of the locomotive are controlled by a set of 32 contactors, arranged in side compartments lined with asbestos. The contactors and the reversing switch installed on one side of the locomotive are worked by an 80-volt auxiliary circuit from a battery of 40 cells. When this battery is exhausted it is replaced at special charging stations.

The adhesion motor when on the adhesion section is used exclusively for the operation of the locomotive. The rack motor at the same time runs idle, at a speed approximately equal to that of the adhesion motor, thus allowing the locomotive to change to rack operation when running at considerable speed.

Synchronism between the loaded motor and the rack

motor running idle is obtained by the field of the latter being in series with the field and armature of the adhesion motor, while the armatures of the two motors are connected

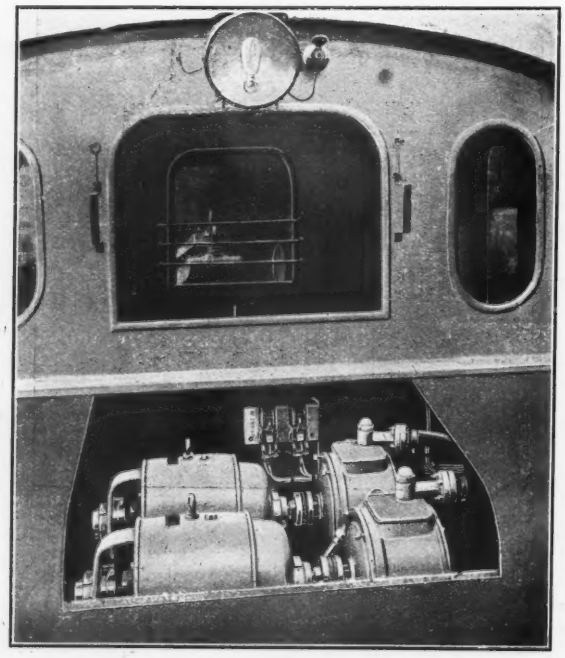


Rigid Inside Frame of Locomotive.

up in parallel. The conditions determining speed are the same for both motors, pressure drop and armature reaction being neglected.

A small resistance connected up to the armature of the rack motor partly compensates for the practically rigid coupling; this is indispensable, as on switching in the current, while the adhesion motor is running, a considerable slackening of speed would otherwise take place, the adhesion motor armature being short-circuited through the idle rack motor armature, while running in a strong field.

The same resistance also gives the system the elasticity required in respect of the wear of the uncoupled wheels, and thus facilitates the entrance on to the rack section.



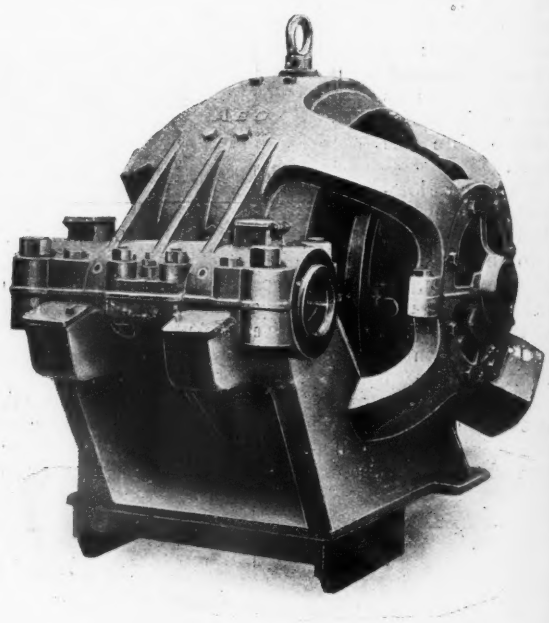
Front View of Locomotive, showing Vacuum Pumps.

The motors are worked on the rack section in ordinary series-parallel connection, with 15 starting steps. During the first nine steps the motors are arranged in series, and during the remainder in parallel; on the ninth and fifteenth steps the motor fields are shunted. By altering the shunt resistances the distribution of load between the two motors, which varies according to the wear of the running wheel diameter, is adjusted as required.

The first six positions of the controller are used to actuate the electric brake. In the case of the short-circuit brake, which is always used in travelling downhill, the armature of one of the motors is connected up in series with the field of the other motor and a set of resistances. This "crossed" brake connection ensures absolute security in braking effect, irrespective of the position of the reversing switch.

The current generated is converted into heat in the resistances which serve for starting.

The arrangement of connections on the locomotive prevents the rack motor from being switched in on the adhesion track, so as to race as a series motor working under no load. This is effected by a relay which



350-H.P. Traction Motor, Usui-Toge Railway.

interrupts the controlling circuit of the contactors carrying the travelling current, and at the same time actuates the vacuum brake of the whole train whenever the "group" drum on the adhesion section is not adjusted to "A." The relay in this case receives current through a switch on the roof of the locomotive, which is actuated by a stop provided on the track besides each rack entrance. If the "group" drum is adjusted to "A," another relay prevents the former from working.

Each locomotive has been equipped with two cable drums each carrying about 60 m. of cable. This arrangement allows two locomotives, at the lower end and in the centre of the train respectively, to be coupled together electrically, so as to be controlled from one driver's cabin.

The pneumatic brake generally used in the case of steam-operated rack locomotives has been replaced by a short-circuit brake, working as described, on amply designed resistances; this brake, on going downhill, is assisted by a vacuum brake, in addition to which a hand-brake, combined with the levers of the vacuum brake and a hand-operated hand-brake working on the driving pinions, has been provided.

The vacuum is generated by two vacuum pumps fitted in the front of the locomotive, one of which works permanently at a low speed, while the locomotive is in motion, thus maintaining the vacuum, and is only operated at full speed in order to release the brake quickly. The other pump serves as stand-by.

The locomotives above described have been in operation for nearly two years. After overcoming a few initial difficulties in connection with the parallel-crank mechanisms, electric operation has been going on quite smoothly, and the excellent results obtained in the service have induced the Japanese Railway Department to consider the electrification of other lines.

TRAMWAY and RAILWAY NOTES.

(*Continued from page* 206.)

Continental.—Italy.—By recent Royal Decrees the following electric tramway schemes have been authorised:—Les Tramways Florentins, three extensions in the city of Florence; Municipality of Milan, two extensions and the conversion to double track of an existing line; Società Anonima Livornese, construction and working of an electric funicular tramway for passengers and goods from a point near the city of Leghorn to the Santuario della Madonna di Montenero; Società Anonima Tramvie e Ferrovie Elettriche di Roma, construction and working of a branch from the existing Genzano-Velletri tramway to Lanuvio (Civita Lavinia); Società Romana Tramways Omnibus, construction and working of a branch from the existing urban tramway at Porta Cavalleggeri to Madonna del Riposa; the firm of Marsaglia (Ditta Marsaglia), concession, without subsidy, for an electric tramway from San Remo to Ospedaletti and Taggia; and the Società Tramvia Elettrica Offida, construction and working of an electric tramway from Offida Castel di Lama to the city of Offida.

Dublin.—Petrol-Electric Traction.—The Dublin and Blessington Tramway Co. has introduced the first petrol-electric car used in Ireland. It is well-appointed, lighted by electricity both inside and outside, and has seating accommodation for 75 passengers. The current is generated by a 65-kw. petrol-electric set in the motorman's compartment, but the car can, if necessary, run over the Dublin United Tramways system—in which case the motors are supplied from the trolley wire in the usual way. Other cars of the same type will shortly be introduced on the Blessington route.

Manchester.—War Bonuses.—The Tramways Committee was paying £7,142 per year in war bonuses, prior to the recent award of the Government Committee on Production, and that is now to be raised to about £17,000 under the award. To have acceded to the request of the workers would have meant an expenditure of over £20,000 per annum.

War Services.—The collections on the tramcars, which have now been suspended for a time, have realised nearly £14,000 for various relief funds. The enlistments from the tramway department number 2,000; the holidays of the present employés are postponed, and staffs are having to work overtime to deal with the work. In the electricity department there have been 320 enlistments, and the office staff is having to work late every night.

Rochdale.—The construction of the new car-shed is to be hung up for some months. An arrangement was proposed whereby the contractors would go on with the work, themselves defraying the expense, and they were to be reimbursed at the end of the war. It now appears that the contemplated arrangement has fallen through.

Salford.—War Bonuses, &c.—The Tramways Committee has agreed to allow Red Cross nurses serving in local military hospitals to use the cars free during the period of the war. A war bonus of 2*s.* each per week has been granted to inspectors, timekeepers and receiving clerks in receipt of 38*s.* per week or less, with a smaller amount to those receiving over 38*s.* and under 40*s.*, sufficient to raise the normal weekly wage to 40*s.*

Worcester.—Electric Vehicle.—The Electricity Committee has recommended the purchase of a 3-ton Edison lorry, but, according to the *Commercial Motor*, the matter has been referred back for further discussion.

TELEGRAPH and TELEPHONE NOTES.

Australia.—Next year's estimates provide for the installation of more automatic telephone systems in Melbourne and Sydney. The amount, according to the Postmaster-General, will be £220 000. No more switchboards of the existing type will be erected in these cities.

Italy.—Certain modifications were made in the telegraphic service when the mobilisation of the Italian army was ordered towards the end of May. Telegrams within Italy and Libya must be in Italian. Those coming from or directed to foreign countries must be in clear language and in French or English. All telegrams are accepted at sender's risk, and no claims or reimbursements for any reason are admitted. In internal telegrams the use of telegraphic addresses and signatures is allowed. The Post Office recommends that letters be posted open, in order to facilitate the work of censorship. Insured letters will, as heretofore, be accepted closed and sealed. For money remittances the use of the P.O. order is recommended.

South America.—From statistics drawn from an American source, published in the *Revista de Correos y Telegrafos*, it appears that the number of telephones in January, 1914, in Central and South America was as follows:—Argentina, 74,296 apparatus; Mexico, 41,861; Brazil, 39,183; Chile, 19,708; Cuba, 16,097; Uruguay, 13,589; Venezuela, 5,029; Peru, 4,000; Colombia, 3,177; Ecuador, 2,926; Panama, 2,635; Bolivia, 2,500; Guatemala, 1,769; San Salvador, 1,728. Argentina thus holds the first place with 32 per cent. of the total number of apparatus. The three States having the largest sums invested in telephones are:—Argentina, £3,246,800; Brazil, £2,261,300; and Mexico, £1,081,700. The revenues from these three premier States were as follows:—Argentina, £1,937,000; Brazil, £1,139,500; and Mexico, £49,400; and the extent of their networks 142,153 miles in the case of Argentina, 49,169 miles in that of Mexico, and 38,304 in that of Brazil, the next in order being Chile with 23,000 miles. The yearly volume of messages was: Argentina, 10,628,000; Chile, 5,900,000; Mexico, 5,285,000; and Brazil, 4,300,000.

CONTRACTS OPEN and CLOSED.

OPEN.

Australia.—Adelaide.—September 1st. Condensers, testing sets, rheostats, Morse sounders, and Wheatstone transmitters for the P.M.G. See "Official Notices" July 23rd.

Perth.—August 25th. Common-battery telephones, for the P.M.G. See "Official Notices" July 30th.

September 29th. Telephone switchboard parts, for the P.M.G. See "Official Notices" July 30th.

Sydney.—September 13th. Council. A.C. and D.C. electric motors. Specification (10*s.* 6*d.*) from E.L. Department, Town Hall.*

September 6th. Metropolitan Board of Water Supply and Sewerage. Centrifugal pumps and electric motors at Richmond pumping station.* Acting Secretary, 341, Pitt Street, Sydney.

August 26th. Telephone parts, switchboard parts, coal-tar composition, soldering solution, and tape, for the P.M.G.*

September 23rd. Condensers, galvanometers, relays, and sounders, also incandescent electric lamps, for the P.M.G.'s Dept. See "Official Notices" to-day.

October 25th. Six electrically-operated wharf capstans, for the Sydney Harbour Trust. Forms of tender from the Engineer-in-Chief, Harbour Trust Offices, Circular Quay.

Melbourne.—September 29th. Fuse blocks (complete and spare porcelain bases and fuse clips) for the Victorian Railway Commissioners. Particulars at the Contractors' Room, Spencer Street.

Hawthorn.—November 30th. Refuse destructor plant, for the Hawthorn-Malvern-Camberwell and Kew Destructor Trust. Specification from the Trust Engineer's Office, Town Hall.

Bristol.—August 23rd. Corporation. One 6,000-kw. three-phase steam turbo-alternator with condensing plant. See "Official Notices" July 23rd.

August 20th. Electric lighting, base supply sheds, Avonmouth, for the Corporation Docks Committee. Mr. T. A. Peace, Engineer Cumberland Road (returnable deposit of £1).

Earby.—August 16th. Dynamo, wiring, &c, for electric light at the sewage disposal works, for the U.D.C. Mr. J. E. Aldersley, Engineer and Surveyor (returnable deposit of £1 1*s.*).

London.—H.M. Office of Works.—August 13th. Twelve months' supply of incandescent electric lamps. See "Official Notices" August 6th.

August 20th. Enamelled electric conduit and fittings. See "Official Notices" to-day.

L.C.C.—August 23rd. Installation (74 wiring points, 93 lighting points) at Winchester Street Elementary School, Pentonville Road, N. See "Official Notices" to-day.

Nottingham.—August 19th. Twelve months' supply of coal for the Electricity Committee. Specification from Mr. H. J. Talbot, Electrical Engineer.

South Africa.—Johannesburg.—August 25th. 8,600 drawn-wire spiral filament traction lamps, spare parts for tramcars, for the Municipal Council.*

September 25th. For the T.C. Two turbo-alternator sets, condensing plant, switchgear, &c. Specification, &c., on deposit of £2 2*s.*, from Mr. J. H. Dobson, General Manager.*

Spain.—Municipality of Cullera, Province of Valencia. Installation of an electric lighting system for that town. Some particulars published in the *Gaceta de Madrid* may be inspected at the Board of Trade Commercial Intelligence Branch in London.

Specifications for the items marked * can be seen at the Board of Trade Commercial Intelligence Branch in London.

CLOSED.

Aldershot.—The U.D.C. has accepted the tender of Messrs. George Kemp & Co., at £89, for alterations to the electricity station.

Australia.—The Melbourne City Council has accepted the following tenders for the Electricity Department:—

Babcock & Wilcox, Ltd.—Four mechanically-fired boilers, £840.
W. & T. Avery, Ltd.—Coal-weighing machine, £2,740.
Strachan, Murray & Shannan.—Two fuel economisers, £1,816.
C. W. Webster.—Arc lamp carbons of Spanish manufacture, £3,431.
—*The Age.*

Dartford.—The Electricity Committee has purchased the following quantities of coal:—

E. J. & W. Goldsmith, Ltd.—200 tons Hetton Wallsend, at 27s. per ton.
Beadle Bros., Ltd.—200 tons Yorkshire rough small, at 25s. 6d. per ton.
John Hudson & Co., Ltd.—Three barges (240 tons) South Hetton, at 26s. 9d. per ton.
J. Waddell & Sons.—100 tons Yorkshire 1½-in. rough small, at 24s. 6d. per ton, and 100 tons Yorkshire 1¾-in. rough small, at 25s. 6d. per ton.

Glasgow.—The T.C. Committee on Tramway Works and Stores recommends the acceptance of the following offers:—Blinds for Govan depôt, Messrs. John Bryden & Sons; Witting armature coils, Manchester Armature Repair Co.

Hampshire.—The County Council has accepted the tender of Messrs. Hill, Upton & Co., at £15,819, for electric plant at Park Prewett Asylum.

Hull.—The Electricity Committee has accepted the tender of Messrs. Dick, Kerr & Co., Limited, at £13,315, for the supply of a turbo-alternator.

Reading.—The T.C. has accepted the tender of Messrs. Dick, Kerr & Co., Ltd., for 12 motors and 12 controllers for tram-cars, with gears, pinions, and gear cases, and standard type "K" controllers, at £1,596 net.

Rotherham.—The tender of Messrs. Chadwick & Co., Ltd., at £1,854, for extending the boiler house at the electricity works, has been accepted.

The Tramways Committee has considered tenders received for the supply of stores, and recommends the Council to enter into no contracts this year for the supply of heavy metal goods, the tram-way manager to purchase them as required. No contracts are to be entered into for the supply of cable and electricity meters during the ensuing year; the engineer is to purchase as required.

Salford.—The Electricity Committee has accepted the tender of Messrs. Gerrard & Sons for alterations and additions to buildings and construction of foundations at the Frederick Road electricity station, in connection with the additional 5,000-kw. turbo-alternators.

Sheffield.—The Electricity Committee has accepted the tender of Messrs. H. Boot & Sons, at £2,853, for the erection of a pump room at the Neepsend power-house.

The following tenders have also been accepted by the Electricity Supply Committee in connection with the emergency Westinghouse generating plant:—

Mellowes & Co.—Cast-iron cistern and brackets, £5.
Stewarts & Lloyds.—Steam pipes, £60.
The Lea Recorder Co., Ltd.—Water-recording apparatus, £115.
Wragg & Biggin, Ltd.—Ironwork, £40.
Sharpe & Co.—Water pipes, £200.
Reyrolle & Co., Ltd.—Switchgear, £240.

Wigan.—The Tramways Committee has placed a contract with the Woods-Gilbert Rail Planer Co., Ltd., for the remodelling of the narrow-gauge track.

FORTHCOMING EVENTS.

Salford Technical and Engineering Association.—Saturday, August 21st. Visit to Messrs. Pilkington's Tile & Pottery Co., Clifton Junction. Ladies invited.

REVIEWS.

Alternating-current Electricity and its Application to Industry, First Course. By W. H. Timbie and H. H. Higbie. London: Chapman & Hall. Price 8s. 6d. net.

The authors state in their preface that this book is planned to meet the need for an elementary text-book on alternating-current electricity, simple enough to be understood by beginners, and, at the same time, complete enough to be a proper foundation for engineering practice or for later advanced study. Accordingly, very little mathematical knowledge is assumed—in fact, an appendix explains the simple trigonometrical functions and their fundamental relations—and the reader is not expected to possess more than a sound elementary acquaintance with the laws of continuous-current electricity.

Beginning with this very modest equipment on the part of their pupil, the authors aim at giving him a knowledge of the subject of alternating currents which shall be at least as thorough as that conveyed by a good many of the text-books which cater for students who start with a much more advanced training. Naturally, the result is a work of considerable dimensions, and the present volume of some 540 pages is only one half of the complete course.

We may say at once that the authors have carried out their plan admirably, and we have nothing but praise for the careful and thorough manner in which they lead the student on step by step from the simplest and most tangible conceptions to those which are more difficult and less easily realised. We would only say that for any student who has had a somewhat broader education than that assumed by the writers, even if he possesses no knowledge of alternating currents, a less laboured treatment would be much more easily followed, and a freer use of equations in mathematical form would be a relief. The reader who has already some general knowledge of electrical engineering will often feel some impatience at the careful but elementary method of approaching every new part of the subject.

Numerous problems and examples are interspersed throughout the book, and afford useful practice for the student who is studying the subject for the first time; while at the end of each chapter is placed a useful summary of its contents in large print, followed by further problems. Perhaps the number of problems (nearly 1,500) is too great for the average student to work through; but as they are well chosen, and many of them are of a very practical character, they may be expected to prove an attractive feature of the book.

It may be useful to give a brief statement of the contents of the volume before us.

The first chapter is devoted to a general descriptive account of modern systems of power transmission, in which the part played by alternating-current machinery and apparatus in the general scheme of power distribution is explained and illustrated.

The second chapter deals with the fundamental ideas of the nature of an alternating current, while the third treats of current and voltage relations and series and parallel circuits. Subsequent chapters deal with power and power-factor; inductive reactance; single-phase generators; polyphase generators; wave-form of generator E.M.F.; armature windings of alternating-current machines.

Hydraulic analogies are freely used in the earlier parts of the book for conveying qualitative and physical conceptions rather than a quantitative or mathematical appreciation of the principles under discussion. While this plan is helpful in the case of a book which is purely introductory in character, it has disadvantages which have already been alluded to in the case of works which have a more extended scope.

The second volume is to contain a more detailed treatment of matters relating to the construction and characteristics of operation of the various common types of alternating-current machines and appliances.

In conclusion, we may repeat that the book is excellent from the point of view of the elementary student who wishes to plod his way steadily and surely to a fair working knowledge of alternating-current machinery and appliances.

Automatic Telephony. By A. B. Smith (formerly Professor of Telephone Engineering, Purdue University) and W. L. Campbell Fellow, A.I.E.E. London: Hill Publishing Co., Ltd. Price 17s. net.

It is not so very long ago since one of our enterprising London dailies asserted with a characteristic tone of finality that automatic telephony was merely an inventor's dream. If any refutation were needed, it is to be found in the comprehensive work before us. Automatic telephony has come, and one has but to glance through these pages to appreciate what has been done in the process of realising this "inventor's dream" and bringing it within the actualities of everyday life.

A considerable amount of literature in the form of contributions to current technical journals and papers read before various societies has appeared on the subject of automatic and semi-automatic telephony, but this work may fairly be regarded as the first exhaustive treatise on these subjects which has yet appeared.

The authors do not attempt to deal with all the various systems in operation, but confine themselves to those types which will prove most important and instructive, although when dealing with long-distance line equipment, central-office design, and development and traffic studies they follow exclusively the practice of the Automatic Electric Co.

The sixteen chapters into which the work is divided deal with trunking, switchboard appliances, subscribers' equipment, the automatic systems of the Automatic Telephone Co., Siemens & Halske, and Lorimer, traffic distributor equipment, the Clement auto manual, Western Electric automatic and semi-automatic systems. The concluding chapters are devoted to long-distance suburban and rural line equipment, power plant and testing equipment, etc., and include some interesting considerations on development studies, office location, ultimate capacities, annual charges, and operating costs, maintenance, etc.

The description of the Siemens-Halske traffic distributor equipment is taken from a paper delivered by the Engineer-in-Chief to the British Post Office before the Institution of Electrical Engineers, and will doubtless be familiar to many

of our readers. Considerable space is given to Clement's semi-automatic system, which, in its present form, and under certain conditions, is a serious rival of the full automatic; and it may be remembered that a number of years ago Mr. Clement predicted that the exchange of the future would be the semi-automatic. Whether Mr. Clement's forecast will eventually prove to have been correct time alone can tell; but there are many to-day who are in agreement with him.

The reader will find no unessential or obsolete matter in this work. The descriptions of systems and apparatus are illustrated throughout with excellent diagrams and reproductions of photographs, which are of great service in enabling one to follow the context.

The authors are to be congratulated on the production of the first comprehensive manual on the subject of automatic and auto-manual telephone.—A.F.

Motor Cycles: A Practical Handbook on their Building, Care, and Management. With special chapters on Ignition. Edited by Bernard E. Jones, Editor of *Work*. London: Cassell & Co., Ltd. Price 1s. net.

The handbook now before us would seem to be the joint product of a number of writers, who all appear to be thoroughly conversant with the sections of the general subject they handle. Whether, however, a good deal of the matter included in the pages will appeal to motor-cyclists is another question, which we cannot altogether answer in the affirmative. For instance, although we have no fault to find with the text, in view of the fact that, as is stated in the book itself, practically all modern motor-cycles are fitted with the high-tension type of magneto for ignition purposes, it seems unnecessary to devote over a fifth of the work to an elaborate disquisition on the now superseded types of accumulator-coil and low-tension magneto forms of ignition. There are also two long chapters which, while interesting and instructive in themselves, will, we fear, appeal to but a limited circle of amateur mechanics. We refer to those entitled "Making a Two-stroke Engine" and "Building a Light Frame and Completing the Machine."

Apart from these subjects, however, there is a good deal of useful matter in the book. The first four chapters, for instance, deal respectively with "How the Engine Works," "The Elements of a Motor Cycle," "Carburettors and Carburation," and "Locating Engine Faults," the different subjects being not only treated in an exhaustive manner but elucidated by clear illustrations. The first chapter should be especially useful to novices, as it deals very thoroughly with the principle of working of internal-combustion engines of both the four and two-cycle type, the latter of which has in recent times made great strides as regards its adoption for motor-cycle propulsion.—C.J.W.

Dynamometers. By Frederick John Jervis-Smith. Edited and amplified by Charles Vernon Boys. London: Constable & Co., Ltd. Price 14s. net.

Than the late Rev. Frederick John Jervis-Smith, M.A., F.R.S., there was no man more competent to present to engineers an authoritative volume relating to dynamometers, a subject which Jervis-Smith had made peculiarly his own. Though trained for the Church, the author of the work under review had immense mechanical aptitude, and soon after he took charge—in 1886—of the Millard Engineering Laboratory attached to Trinity College, Oxford, he did work on the measurement of the torsion of rotating shafts which is the basis of the means now adopted on large turbine steamships for measuring the power transmitted by the turbines. We are reminded of this fact, and also of his interest in telephonic matters, in an excellent obituary notice which the editor of the volume, Mr. Charles Vernon Boys, F.R.S., has included in Jervis-Smith's monumental work. In his introductory chapter the author emphasises the importance of dynamometric methods, and quotes John Penn's dictum of 1858: "There could not be too many dynamometers," which is peculiarly true to-day, when the need for exactitude in machine construction and power measurement is greater than ever. As the author says, "the dynamometric test either of a prime mover, such as a steam or gas engine, or of a driven machine, such as a dynamo or spinning loom, should form a definite part of the workshop procedure of the mechanical and the electrical engineer, since such tests would definitely show progress or the reverse in the machine produced in the works."

The three classes into which dynamometers may be divided—the gravity, the frictional, and the transmission forms—are considered in order by the author, and well-known types, such, for example, as those by Brotherhood, Morin, Heenan and Froude, Morris and Lister, and Watson, are described with the help of illustrations, in which the volume is unusually rich. Jervis-Smith's own machines, of course, not being omitted. The chapter dealing with dynamometric tests of motor-car engines and high-speed internal-combustion engines, and the peculiar difficulties—*e.g.*, the necessity for flexible couplings—which are introduced by the testing of such engines, is not the least interesting and valuable section of a book which the editor has succeeded in bringing right up-to-date, and on which he is deserving of the congratulations as well as the thanks of all engineers engaged on testing work.

NOTES.

The "Electrical Review" Telephone Number.—We shall be obliged if our readers will kindly take note that the number of our telephone for the Editorial Department is unaltered, but for Advertisement and other business communications the number has now been changed from Holborn 933 to **City 997.**

Field Telephones.—Before the Royal Society of Arts on July 28th, Mr. Chas. R. Darling delivered a special war lecture, with experimental illustrations, on "Field Telephones." The speaker dealt with the duties of the field telephonist, and with the components and operation of field telephones as now used in the British Army. The Japanese were the first to make extensive use of the telephone in large scale warfare, and, during the past year of trench warfare, the telephone has proved an indispensable and generally the only practicable means of communication in the fighting zone.

As source of current two small dry cells are invariably employed. These rapidly become exhausted, and the range of voltage for satisfactory communication is only from 1·5 to 1·3 volts per cell. A high-pitched buzzer is used for calling purposes and also for telegraphic communication by Morse code. Speech transmission is rarely practicable near the firing line. To save weight and space the induction coil and buzzer may be combined in a single apparatus, and the latest Service buzzer, the D-Mark III, with bipolar, double-wound magnets and a double-ended reed oscillating about its centre, gives a remarkably pure and even note, considerably better than that given by older patterns of buzzer with reeds vibrating about one end. Watch pattern receivers and carbon granule microphones are invariably employed. With a head receiver strapped in position, a sleeping operator is awakened with certainty by the calling buzzer. Earth return is always employed, and since the receiver cord forms part of the line circuit, there is special advantage in using two receivers in parallel, apart from the possibility of two persons then listening at once to important messages. The standard D-Mark III field set, complete with leather case, weighs just over 8 lb. Certain privately-manufactured sets, which are now being used in addition to the Service equipment, are a little lighter, but have not the special Mark III buzzer.

For quite temporary communication, the Japanese practice of using single iron wire lines varnished for insulation, is generally followed. Such wire is not worth picking up again. More permanent installations demand the use of stranded steel wire with weatherproof insulation; copper is never used, chiefly on account of the ease with which it is broken. To prevent frequent interruption of service by spies cutting wires or by shell splinters breaking the lines, an irregularly-constructed "ladder" line is often used, this consisting of two main lines interconnected by as many "rungs" as possible. Many branches in the network thus formed may be broken before through communication is interrupted, but it is not always easy to make the numerous joints required when laying the line, and earth faults at breaks may place the line out of service in wet localities before through connection is broken. An alternative is to provide multiple conductors brought into one or more intermediate "dug-outs," but not interconnected by rungs. Operators in the intermediate dug-outs test the lines at frequent intervals and make cross-connections as required to replace a broken section of one line by the corresponding section of one of the other lines available. A broken line being thus disconnected, gives no trouble by earth faults.

In conclusion, Mr. Darling pointed out that drill, discipline and bravery were not sufficient to make a useful telephonist. Knowledge of the construction and methods of working and repairing his instruments was essential, and the speaker suggested that teachers from polytechnics and secondary schools, now on vacation, should offer their services to train field telephonists. If electricity and physics teachers would do this, substantial units of trained telephonists could quickly be formed in every district, and though his suggestion in this respect was not in any way "inspired," he hoped some definite arrangement might be made to apply the voluntary effort of technically trained civilians to this most important military need.

Foreign Trade.—The July Figures.—The following are the electrical and machinery figures given in the official returns for July:—

	Month of July.		*Inc. or dec.*	*Seven months, 1915.*		*Inc. or dec.*
Imports.	£		£	£		£
Electrical goods and apparatus, excluding machinery and uninsulated wire	98 243	−	41,098	553,456	−	390,535
Machinery ...	896,510	+	263,578	5,273,900	+	496,624
Exports.						
Electrical goods and apparatus, excluding machinery and uninsulated wire	262,051	−	92,534	1 749,049	−	309,765
Machinery ...	1,715 229	−	1,589,659	11,515,970	−	11,258,473

The Electric Vehicle Association of America.—The annual meeting of the Association is to be held in Cleveland, O., in October next. The Association now embraces 16 local sections, and has an individual membership of 1,058, the 1,000 mark having been passed in June last.

New Inventions Board.—The Minister of Munitions has constituted a Munitions Inventions Branch of the Ministry, and has appointed as Comptroller Mr. E. W. Moir, M.Inst.C.E.

The branch, which for the present is located in Armament Buildings, Whitehall Place, will have the duty of considering projects for inventions relating to munitions for warfare on land, or matters appertaining thereto.

The Comptroller and staff of the branch will be assisted in their work of examination, and, if thought necessary, in the investigation and development of any projects that may be considered worthy of being developed, by a panel of honorary scientific and other experts. Amongst those who have accepted Mr. Lloyd George's invitation to act on this panel are :—

Mr. W. Duddell, Dr. S. Z. de Ferranti, Dr. Glazebrook, Sir Robert Hadfield, Sir Alexander Kennedy, Mr. F. W. Lanchester, Mr. Michael Longridge, Mr. W. H. Maw, Sir Hiram Maxim, Sir Henry Norman, Mr. F. G. Ogilvie, Mr. James Swinburne, Sir J. J. Thomson, and Mr. A. J. Walter, K.C.

All communications should be addressed to the Comptroller at the above address.

Institution and Lecture Notes.—Institute of Metals.—The following are amongst the papers to be submitted at the meeting of the Institute of Metals on September 17th :—"The Corrosion of Gun-Metal," by Dr. C. H. Desch ; "A Thermostat for Moderate and High Temperatures," by Messrs. J. L. Haughton and D. Hanson ; (*a*) "Structural Changes in Industrial Brasses," (*b*) "Hardness of Copper-Zinc Alloys," by Dr. D. Meneghini ; "Specifications for Alloys for High-Speed Superheat Steam Turbine Blading," by Mr. W. B. Parker ; "Detection of Internal Blow-holes in Metal Castings by Means of X-Rays," by Mr. C. H. Tonamy. Further particulars can be obtained from Mr. G. Shaw-Scott, Secretary, Caxton House, S.W.

British Association.—Amongst the papers to be read at the meeting on September 7th-11th, at Manchester, are the following :—"Thermal Efficiency of a Gas Engine," by Professors Asakawa and Petavel ; "Apparent Specific Heats in Gaseous Explosions," by Prof. W. M. Thornton ; "Gas-Producer for Steam Boilers," by Mr. E. C. Mills ; "Thermal Conductivity of thin Air Films," by Mr. A. A. Griffith ; "Electric Oscillations in Coupled Circuits," by Dr. Eccles and Mr. A. J. Makower ; "Capacity of Aerials," by Prof. G. W. O. Howe ; and "Eddy-Current Losses in End-Plates of Turbo-Generators," by Prof. Miles Walker.

Volunteer Notes.—Engineering Institutions' Volunteer Training Corps.—Headquarters—Marconi House, Strand, London, W.C.

Company Orders.—By Lieut.-Colonel C. B. Clay, V.D., Commandant, for week ending August 21st, 1915.

Monday, Wednesday and Friday.—Drills, 6.30 and 7.30 p.m.

All applications for enrolment should be sent to the Commandant, Marconi House, Strand, from whom all particulars can be obtained.

E. G. Fleming,
Company Commander and Acting Adjutant.

The General Committee of this Corps includes the names of many of the prominent members of the three principal branches of Engineering, and among them we note the Presidents and also the Secretaries of the Institutions of Civil, Mechanical and Electrical Engineers. The Corps has not only the hearty support of the heads of the engineering profession, but is warmly supported by General Sir O'Moore Creagh, V.C., the General advising the Central Association V.T.C.

To enlarge the usefulness of the Corps further recruits can be accepted either from among the membership of the Institutions, or from others who are willing to be trained in fortress engineering work under the Staff of the London Electrical Engineers (T.F.), at their Headquarters in Westminster.

3rd Battn. (Old Boys') Central London Regiment (Volunteers).—Battalion Orders by Colonel S. G. Grant (Officer Commanding), Thursday, August 11th, 1915 :—

Week-end Parades.—Saturday.—The Battalion will parade as strong as possible at Cumberland Gate, Regent's Park, 2.30 p.m., on Saturday next, the 14th inst., and proceed by march route to Wembley, *viâ* Gladstone Park. Dress : Full parade kit with rucksacks.

Sunday, 7 a.m., Reveille ; 10 a.m., Church Parade ; 10.20 a.m., Parade under Company Commanders ; 2.15 p.m., Battalion Parade.

Musketry.—Acton Range will be open for those who have not yet qualified, as follows :—Tuesdays, 2.30 p.m., "B" and "D" Companies ; Thursdays, 2.30 p.m., "A" and "C" Companies ; Saturday, voluntary. First 21 men sending in their names to Headquarters not later than Friday, 6 p.m.

Bisley Range.—On Saturdays, as usual, for men who have qualified at Acton, and not yet shot at Bisley, 12.45 p.m., at No. 9 Barrier, Waterloo, under Sergt. Cotter and Corp. Crabbe. Names to be in at Headquarters by Fridays mid-day.

A. G. Joiner, *Captain and Adjutant.*

Lieut. Greely and His Patent Insulator.—A good story is told of the experiences of the late General A. W. Greely, at one time chief of the Signal Corps, U.S.A., with a patent telegraph insulator.

Lieut. Greely—he was a plain lieutenant then—went to Texas in November, 1875, to build a telegraph line to San Antonio from Fort Brown. He had an insulator which he and other experts had gotten up in Washington especially for this line. It consisted of a well-lacquered sheet-iron cap over a dry wood screw and had the general appearance of a tomato can on the end of a broomstick, when in position.

The line was built 400 miles and for two weeks or a month it worked like a dream. Suddenly warm weather set in, and when warm weather strikes lower Rio Grande it takes hold for keeps. The thermometer crawled up to 100, and after several weeks of this spell the line began to get mysterious kinks in it. There was trouble somewhere and plenty of it. The line was not down, but it seemed to have its grip on all through messages. San Antonio had to do all its business with Fort Brown by relaying at Laredo. In a few days Laredo could only telegraph as far as Ringgold Barracks, south, or to Fort Clark, north, and through messages from San Antonio to Fort Brown had to stop off three times *en route* and take a rest. At the end of the week the trouble was worse, yet Lieut. Greely sent couriers galloping down the whole circuit. They could not find a place where the wire was down or in contact with trees or with anything else, but they reported something queer with the "insulators." Lieut. Greely was wild with indignant surprise. The idea of an insulator going wrong which had been concocted in Washington especially for Texas. Still the telegraph line was not working any better as a telegraph line than as a fish line or a clothes line, so he borrowed a mule from a quartermaster and started out to investigate. He came back in light marching order that evening with a sad secret in his heart, several lumps on his countenance and minus the wayward army mule.

The simple truth was that the Texas hornets, which are lazy beasts, thought the new insulators were a shelter kindly provided by the Government for their special use and had gone to work and filled every blessed one of them from San Antonio down with mud, sour honey and general cussedness and the line was literally 400 miles of Hades in active eruption. Lieut. Greely wrote to Washington experts, who promptly got a new breed of insulators, solid as a brick and burglar proof. They were shipped and Lieut. Greely induced a gang of unsuspecting linemen to sign a cast-iron contract to take the old insulators off. The "repairing" party left Fort Brown on April 10th. By this time the hornets had raised an uproarious family in each insulator and the first lineman who shinned up to serve the writ of ejectment got a dose of trouble that made his hair curl, and in his haste down let the pole slip up through his hands, burning them, besides taking all the buttons off his clothes. The way the hornets expressed their opinion of signal service hospitality was sinful. It cost the contractor 46 able-bodied men, 19 barrels of bread poultice and a cask of refined arnica to "repair" the first eight miles, and operations ceased. When the linemen got so they could see well enough out of one eye to shoot, they went gunning for Lieut. Greely, but he had already fled the State in a blue fog, and the next that was heard of him he had barricaded himself somewhere in the neighbourhood of the North Pole. The line remained in an active and warlike status until winter and the telegrams were forwarded by the aid of a slow but persevering mule. After the first blizzard had calmed the hornet families into solid lumps, the contractor resumed his labours and recouped his loss by shipping the insulators to Baltimore for canning clams, and seven dozen crates of assorted stings to England for sale as sewing machine needles.—*Telegraph and Telephone Age.*

Fatalities.—George Fernie, a young electrical engineer, was killed almost instantaneously in the new pit at Kinglassie Colliery, Fife, through coming into contact with a live wire.

Archibald Hemingway, 39, a car cleaner in a Halifax tramway shed, was cleaning the top of a double-decked car when another cleaner heard a scream and saw Hemingway lying on his side in a state of collapse. He died shortly afterwards. It is thought that the insulation of the electrical equipment of the car was damaged in the storm the previous day, and that Hemingway touched a live part.

Appointments Vacant.—Three shift engineers (£104) and switchman (37s. 6d.), for Birmingham electric supply department. Particulars are given in our advertisement pages.

Educational Notes.—University of Edinburgh.—The preliminary or entrance examinations in the Engineering Department will be held in September for the new session, which opens on October 12th.

Northampton Polytechnic Institute.—The Engineering Day College entrance examinations in Civil, Mechanical, and Electrical Engineering will be held on September 28th and 29th. Day Courses commence October 4th. Particulars are given in our advertisement pages.

Smoke Abatement.—The proposed Smoke Abatement Exhibition to be held at Glasgow has been postponed, at the request of the Board of Trade Armaments Committee, as manufacturers at present employed in the manufacture of munitions who might exhibit require all their time and attention for the output of Government work.

Capturing Foreign Trade.—The following letter, signed "W. G. S.," appeared recently in the *Journal of the British Chamber of Commerce for Italy* (*Inc*) :—"Will you allow me to point out how our foreign trade is handicapped ? I am a commercial traveller representing a British house on the Continent of Europe. Fortunately for me, my firm has adopted the metric system, otherwise business would be impossible. There are, however, thousands of British manufacturers who could get a footing in Continental markets, but who fail to do so, not through any

fault in their products, not even because their prices may happen to be high, but solely because they refuse to quote and invoice in decimal coinage and in metric weights and measures.

"Time after time have customers shown me offers received from British firms, the same being made out in £ s. d., cwt., qr., lb., ft., in., &c. What we have to realise is that such offers are largely meaningless to the Continental buyer, and that if we wish him to purchase our goods we must at least make ourselves intelligible to him.

"Naturally, great waste and inconvenience are caused in having to convert from one system to the other. Why, then, cannot we as a nation boldly adopt the international standards, and so facilitate our trade with other countries?

"The metric system is now taught in our elementary schools. It is so simple that it can be mastered in a few minutes. It is conducive to accuracy and rapid reckoning. Being a time-saver, it lowers the cost of production. We wish to extend our foreign trade. Then why handicap ourselves by retaining methods which our competitors have discarded as obsolete?"

New Battery Signalling Bell.—At a meeting of the North of England Institute of Mining and Mechanical Engineers at Newcastle-on-Tyne, on the 7th inst., Dr. W. M. Thornton read a paper on "A New Battery Signalling Bell." He spoke at some length on the igniting power of an electric break-spark, and in demonstration caused a considerable explosion, which left no sign upon the bell apparatus. The new device, which could be fitted to any existing bell, was a small attachment by means of which the spark at the trembler contact was prevented, the current which caused the spark being diverted through a by-pass. So long as the device was in normal action ignition could not occur. In a letter, Mr. H. R. Kempe (late of the G.P.O.) expressed the opinion that the use of the device should be made compulsory, while Dr. Wheeler, of the Home Office, wrote that he had tested the new bell, and could testify to its efficiency.

OUR PERSONAL COLUMN.

The Editors invite electrical engineers, whether connected with the technical or the commercial side of the profession and industry, also electric tramway and railway officials, to keep readers of the ELECTRICAL REVIEW *posted as to their movements.*

Central Station Officials.—The Salford Electricity Committee has granted permission for the borough electrical engineer to act on the Sub-Committee of the Manchester Munitions Committee, with respect to the appointment of inspectors for the inspection of war materials.

The Ilkley District Council has approved the appointment of MR. S. H. BILL as electrical engineer and manager as from August 1st, at an annual salary of £250. Mr. Bill received his early training at Birmingham University and with the Westinghouse Co., including six months in America. Afterwards he visited South Africa, and upon his return was appointed chief electrical engineer to the Mersey Dock Board; he was later chief engineer of a large brewery in Birmingham, but resigned this post to take the position of clerk of works in succession to Lieut. Wilkinson, of Harrogate, who is now a prisoner of war in Germany. Mr. Bill was granted a commission in the Army Service Corps at the outbreak of war—he having already resigned his position with the Birmingham brewery to take up a position in Germany, which he had to relinquish owing to the war—and was engaged in commandeering motor vehicles for the service. His commission was, however, later cancelled on account of an old bullet wound.

The Kingston-on-Thames T.C. has increased the salary of MR. KINGHAM, chief assistant at the electricity works, to £3 per week, with an advance to £3 10s. in November next, and to £4, a year later.

MR. W. E. CLARET, station superintendent at the Maidenhead Corporation electricity works, has accepted the appointment of chief electrical and mechanical engineer to the British Xylonite Co., Ltd. He is succeeded by MR. W. LEIGHTON CHUBB, of Stafford. MR. H. D. GAMBLE, of the electricity staff, has also resigned.

MR. DAVID DUNN, of the Kilmarnock electrical and tramway department, who has received an appointment in London, has been presented with a suit case, and an umbrella for Mrs. Dunn. Mr. Dunn was formerly with Messrs. Siemens Bros. and the Silvertown Co., and for six years had charge of the electric power plant at Messrs. Andrew Barclay's works.

We are informed that an error occurred in the paragraph in our last issue, which stated that MR. R. H. FOX had been appointed chief electrical engineer at Musselburgh; Mr. Fox has been appointed chief assistant engineer, and his salary is not as stated.

MR. R. H. PARSONS, superintendent of the municipal power plant at Edmonton, Alta., has tendered his resignation to the Commissioners, and has returned to Manchester, England, where he is now connected with a large factory engaged in the manufacture of munitions of war. MR. C. E. COPE, chief engineer of the plant, has been recommended to succeed Mr. Parsons.

Tramway Officials.—Another Blackburn soldier has been commended for gallantry in the field, the honour falling to Private F. GEETSON, who was formerly employed in Blackburn Corporation tramway department.

The marriage took place at Oxton, on July 31st, of LIEUTENANT SAMUEL WILFRID CARTY, of the Army Service Corps (Mechanical Transport), who was chief of the overhead line department of the Birkenhead Corporation Tramways, and Miss Maud Eleanor Hedley daughter of the late Mr. Matthew Hedley, Chief Inspector, Department of Agriculture for Ireland.

MR. C. R. EVERSON has been appointed manager of the Plymouth Corporation Tramways for a period of three years, at £450 per annum, with house.

General.—The marriage took place last week at Hallgarth Church, of MR. J. CRAGGS, electrician at Horden Colliery, and Miss Edith Thompson, daughter of Mr. John Thompson, Sherburn Hill (Co. Durham).

Second-Lieut. ARTHUR R. CROKER, who was on the staff of the British Insulated and Helsby Cables, Ltd., of Prescot, has been gazetted temporary Lieutenant in the Second Field Company, Home Counties' Divisional Engineers.

Lance-Corporal P. V. STENT, of the Fifth Service Battalion, Oxford and Bucks Light Infantry, who was on the staff of Messrs. Willans & Robinson, has been awarded the D.C.M. for service in France.

On the occasion of his marriage to Miss Nellie Howard Halford, elder daughter of Mr. John Halford, of Rugby, MR. JOHN P. THOMPSON, son of Councillor J. Thompson, J.P., of Stanhope (Co. Durham), has been presented with a marble clock by the staff of the Loughborough Electrical Engineering Co.

In the list of aliens to whom certificates of naturalisation were granted during July the following appear:—

CHRISTIAN FREDRIK BARNHOLDT (Sweden), electrical engineer, residing at Preston.

FREDERICK WILLIAM BECKER (Germany), telegraph engineer, residing at New Barnet.

MR. A. S. BRODIE, contract manager for the Post Office telephones at Blackburn, is about to leave to take up a similar appointment at Aberdeen, and it is understood that the Blackburn vacancy is to be filled by the transfer of MR. SHEARS, who is at present contract manager at Chester.

Lance-Corpl. WM. STENTON, 8th Batt. Manchester Regiment, who has just been awarded the D.C.M., was till recently employed at the British Westinghouse Co.'s works.

MR. V. A. F. BELLAMY, second assistant engineer of the Manx Electric Railway Co., has been appointed assistant outside supervisor to Messrs. J. B. Saunders & Co., of London.

MR. D. H. SLACK, of the firm of Messrs. Bauer, Imrie & Slack, chartered patent agents, has been promoted to the rank of Captain in the Kent Fortress R.E. (Lights Companies).

Roll of Honour.—Rifleman HENRY OAKWELL WOOD, of the Rifle Brigade, who was on the staff of the Kingston-on-Thames Corporation electricity department, has been killed in action in France.

Private ROBERT DENNIS, of the 7th Battalion Lincs. Regt., who was with the Urban Electricity Co., at Stamford, has been killed in action. He joined the regiment last August, although in his 50th year, and went to the Front a month ago. With the 2nd Lincoln Regt. he went through the Boer War.

Private A. H. DAY, of the 7th West Yorkshire Regiment, who was on the electricity staff at Leeds of the Great Northern Railway Co., has died from wounds received in action.

Sergeant GEO. WM. JACKSON, D.C.M., of the Coldstream Guards, who has been killed in action in France, served his apprenticeship with Messrs. Siemens Bros. at Stafford. He joined the Guards last September, and went to France in December.

Lieut. H. L. DOWNES, of Messrs. Downes & Davies, electrical supply agents, of Stanley Street, Liverpool, is reported as "believed to be killed" in action in France. Lieut. Downes was last seen during a bombardment of the trenches, getting bombs through to the front. He was in the Irish Battalion of the King's Liverpool Regiment, and went to France in April.

Obituary.—The death recently occurred of MR. ERNEST J. MAYNE, late of the electricity supply department, Dublin.

Will.—The estate of the late MR. C. E. P. SPAGNOLETTI, of Frognal Lane, Hampstead, late chief electrical engineer to the Great Western Railway Co., has been proved at £35,070.

NEW COMPANIES REGISTERED.

Snyder Electric Furnace Co., Ltd. (141,210).—This company was registered on August 6th, with a capital of £1,000 in £1 shares, to acquire and turn to account any inventions relating to the manufacture of iron, steel, metals and chemicals of all kinds, to carry on the business of electrical, mechanical and general engineers, founders, machinists, tool makers, chemical manufacturers, etc. The subscribers (with one share each) are: G. J. Stock, The Villas, Middleton St. George, Darlington, analytical chemist; C. J. H. Stock, 34, Swinburne Road, Darlington, analytical chemist. Private company. The number of directors is not to be less than three or more than seven; the first are G. J. Stock, C. J. H. Stock, G. H. Watson, and F. T. Snyder. Qualification, £1. Solicitors: Watson & Watson, Darlington. Registered by Jordan & Sons, Ltd., 116-7, Chancery Lane, W.C.

Accumulators, Ltd. (141,197).—This company was registered on August 6th, with a capital of £100 in £1 shares, to carry on any business bearing on the application or employment of electricity, electrical batteries and accumulators, and the business of engineers, machinists, etc. The subscribers (with one share each) are: W. J. Matthews, 69, Freegrove Road, W., accountant; H. Fulton, 1, Lawrence Pountney Hill, E.C., solicitor. Private company. The number of directors is not to be less than two or more than five; the subscribers are to appoint the first directors. Qualification, one share. Registered office: Maybury Hill, Woking.

Irish Hydro-Electric Syndicate, Ltd. (141,203).—This company was registered on August 6th, with a capital of £10,500 in 10,000 ord. shares of £1 each and 10,000 shares of 1s. each, to acquire water and other power, and rights and concessions in respect of the use of waterfalls, rivers and waterways for the generating of power, and any other properties and hereditaments, to carry on the business of suppliers of power by water and electricity, etc. The subscribers (with one share each) are: E. J. Hayman, 18, St. Swithin's Lane, E.C., secretary; W. Pocock, 11, Bowen Road, Harrow, clerk. Private company. The number of directors is not to be less than two or more than five; the subscribers are to appoint the first. Registered by Ingle, Holmes Sons & Pott, Capel House, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Simmonds Brothers, Ltd.—Charge (supplemental to various agreements) on moneys payable under army contracts, dated July 22nd, 1915, to secure all moneys due or to become due from company to Parrs Bank, Ltd.

Colley's Patents, Ltd.—Particulars of £6,000 debentures, created by resolutions of January 2nd, 1906, March 14th, 1907, and July 8th, 1915, filed pursuant to Section 93 (3) of the Companies (Consolidation) Act, 1908, the amount of the present issue being £3,000. Property charged: The company's undertaking and property, present and future, including uncalled capital. No trustees.

Carville Site and Power Co., Ltd.—Issue on July 28th, 1915, of £10,000 debentures, part of a series of which particulars have already been filed.

La Plata Electric Tramways Co., Ltd. (101,431).—Capital, £450,000 in 200,000 pref. and 250,000 ord. shares of £1 each. Return dated May 11th, 1915. All shares taken up; £170,007 paid on 170,007 pref.; £279,993 considered as paid on 29,993 pref. and 250,000 ord. Mortgages and charges: £100,000.

Nairobi Electric Power and Lighting Co., Ltd.—Issue on July 26th, 1915, of £1,000 debentures, part of a series of which particulars have already been filed.

Hart Accumulator Co., Ltd.—Charge on 35 and 10, Marshgate Lane, Stratford, dated July 27th, 1915, to secure all moneys due or to become due from the London County and Westminster Bank, Ltd., Lothbury, E.C.

Pritchett and Gold and Electrical Power Storage Co., Ltd.—Deposit on July 29th, 1915, of deeds of freehold land and buildings at Highfields, Feltham, dated July 29th, 1915, to secure all moneys due or to become due from company to Barclay & Co., Ltd., 95, Victoria Street, Westminster. Stamped to cover £4,000.

CITY NOTES.

Tyneside Tramways and Tramroads Co.

The directors' report for the half-year ending June 30th, 1915, shows a surplus of receipts over expenses of £5,411, which, with the balance brought forward from last half-year of £732, makes a total to the credit of profit and loss account of £6,143, and after deducting interest on debentures, loans, etc., amounting to £1,012, there remains an available balance of £5,131. This profit the directors propose to appropriate as follows:—Dividend on preference shares at the rate of 5 per cent. per annum (less income tax), £601; dividend on ordinary shares at the rate of 3 per cent. per annum (less income tax), £2,008; reserve for renewals, depreciation, and other contingencies, £1,200 (this, with £303 interest on investments, will increase the fund to £20,666); reduction of registration and formation expenses, etc., £330, leaving to be carried forward to next half-year £991. The traffic receipts show a decrease of £422, as compared with the corresponding period of last year. The shareholders are asked to sanction the contribution by the company to charitable purposes in connection with the war of a sum not exceeding £200 during the half-year ending December 31st, 1915.

The half-yearly meeting of the company was held at Newcastle-on-Tyne on the 10th instant, Dr. J. T. Merz (the Chairman) presiding. In moving the adoption of the report, the Chairman said the revenue had been £400 less than in the corresponding half-year, and the profits had been almost exactly the same as last half-year. A very large item in the receipts in the first half of the year was usually the holiday traffic; this traffic, owing to the races at Gosforth Park not having been held this year, had been very much less. They had lost in that way, compared with the corresponding half-year, £1,457, but on the other side they had made up about £1,000 on the ordinary traffic, owing to the increased workmen's traffic. They had been obliged to run fewer cars owing to the reduced staff. The receipts per car mile had gone up from 10.48d. last year to 11.06d., and the expenses had gone up from 6.58d. to 7.15d. The expenses had been the same for the half-year as in the corresponding six months, although wages had gone up. Their men had been very loyal, and had worked considerable overtime. The dividend they proposed was the same as last year. The reserve fund amounted to £20,666. They had invested £20,306, but as against that they had a debt to the bank of £4,000. They had exercised the option of converting Consols into War Loan, and they would hold over £9,000 in the Loan, which would be nearly half of their reserve fund. This would mean an increase of £23 in their income. They had insured against aircraft and bombardment for £20,000, and that would cost about £86. The traffic receipts were still going up.

Mr. George E. Henderson seconded the adoption of the report, which was carried.

A letter was read from two shareholders protesting against the proposal to devote £200 to charitable purposes. It was stated that a similar sum was given last half-year.

The Chairman explained that they had only spent £132 of the sum last voted, of which £98 was paid to the dependents of men who had enlisted, so that only £34 was spent on charitable contributions, which was equal to the amount that the employés had spent.

The meeting agreed to the proposed contribution.

French Electrical Companies.

The extracts published a few weeks ago from the annual reports of various French supply companies showed, in general, that they have suffered from the effects of the war, whilst in the case of the Parisian companies in particular a further disadvantage was experienced by the transfer of their undertakings within the municipal area of the city to the Compagnie Parisienne de Distribution d'Electricité at the beginning of 1914. The unfavourable results find fresh confirmation in the following list of other companies engaged both in the supply business and transport services:—

The *Compagnie Générale de Distribution d'Energie Electrique* records net profits of £28,000 for 1914 on an ordinary share capital of £640,000, this sum comparing with £50,900 in 1913. No dividend is in contemplation, whereas £1 per share was distributed in the previous year.

The *Société Lyonnaise des Forces Motrices du Rhône* earned net profits of £97,000 in 1914 on a share capital of £1,200,000. The sum of £41,000 has been allocated to an experiment account, and the balance allows of the distribution of 12s. 7d. per ordinary share, as contrasted with 18s. 9d. in 1913, but the holders of deferred shares, who received 19s. 7d. in 1913, have been passed over for 1914.

The *Compagnie des Tramways de Paris et du Departement de la Seine*, which has an ordinary share capital of £2,200,000, realised net profits of £70,000 in 1914, as contrasted with £87,000 in the preceding year. Notwithstanding the decrease, the dividend remains at 8s. per share, as in 1913. As fresh capital is needed, and the issue of a definite loan appears to be doubtful of success for the present, it is intended to raise the money by the offer of short-term bonds for £500,000.

The *Compagnie Générale des Omnibus de Paris*, which not only monopolises the motor omnibus services, but also the principal tramways in the central parts of the city, reports that the conversion of the lines to electric traction was completed in 1914. After the motor 'buses were requisitioned by the military authorities the receipts were solely derived from the tramway traffic, the compensation paid for the vehicles being £893,000, which is said to represent an appreciable loss to the company. The net profits have permitted of the payment of a dividend of 16s. per share on the capital of £3,320,000, the loan capital amounting to £4,000,000.

The *Société Le Triphasé* (*Nord Lumière*), which is a subsidiary of the Secteur de la Place Clichy, experienced a heavy decline in the net profits in 1914 in consequence of the dearness of coal and the great diminution in the consumption to 63 per cent. of the former average consumption. As a result, the net profits receded from £143,000 in 1913 to £8,000 last year, and the dividend from 29s. 3d. per share to no distribution in the two years respectively. The ordinary share capital is £607,000, and the loan capital £453,000, of which the sum of £365,000 is invested in other electricity supply undertakings.

The *Société du Secteur de la Place Clichy*, whose supply undertaking was absorbed by the Compagnie Parisienne de Distribution d'Electricité on January 1st, 1914, has since devoted its efforts to the supervision of subsidiary companies, including the Triphasé. The net profits for 1914 are returned at £16,000, as compared with £100,000 in 1913, when a dividend of £5 8s. per share was declared, but no distribution is proposed for last year. The repayment of share capital of £240,000, which was decided upon in July, 1914, has been rendered impossible, as the partial disposal of shares held in the Triphasé has been out of the question under the changed circumstances.

The report of the *Société d'Eclairage et Force par l'Electricité*, which was formerly known as the Secteur Rothschild, discusses the unsound rivalry which prevailed among the different lighting companies in connection with competitions for concessions, and mentions that the concession for the district of St. Denis has been transferred to the Compagnie Parisienne de Distribution. At present the Société d'Eclairage only carries on, or is interested in, suburban and provincial concessions, and under the altered conditions the gross profits declined from £166,000 in 1913 to £34,000 last year, and the net profits from £38,000 to £22,000 in the two years respectively. It is, however, not intended to pay any dividend.

Victoria Falls and Transvaal Power Co., Ltd.

The report for the year ended December 31st, 1914, states that the issued share capital amounted to £3,000,000 and the debenture capital to £4,543,920, £82,580 of the 5½ per cent. second mortgage debentures having been purchased during 1914, towards the amounts falling due for redemption in January, 1915, and January, 1916, in the terms of the trust

deed. The year's business has resulted in a profit of £555,694, which, with the £105,199 at the credit of the profit and loss account as at December 31st, 1913, remaining after payment of the dividend on June 17th, 1914, makes a gross total of £660,893. After providing for interest on debentures for the year 1914, amounting to £234,843, and for depreciation, income tax, etc., amounting to £159,603, the balance remaining is £266,447, in respect of which a dividend was declared on December 17th last, at the rate of 6 per cent. per annum, less income-tax, for the six months ended June 30th, 1913, on the preference shares, and a further dividend on the preference shares also at the rate of 6 per cent. per annum, less income-tax, for the ten months ended April 30th, 1914, was declared on June 10th, 1915. These dividends were paid on January 6th, 1915, and June 21st, 1915, respectively, and absorbed £160,000, leaving £106,447 to be carried forward. Since the last report three 10,000-H.P. compressors have been brought into commission, together with the necessary boiler plant, etc., and considerable extensions to the air pipe system of the Rand Mines Power Supply Co., Ltd., have been made and put to work. At the Brakpan power station 33,500 H.P. of electrical plant has been added and half of this is now in commission. The combined companies have now an ample reserve of air and electrical plant installed at their several stations. The judgment which was given against the company in the action by the Consolidated Langlaagte Mines, Ltd., was reduced by the Appeal Court from £29,000 to £19,000.

The directors record the death of Mr. R. G. Fricker, and the vacancy on the board has been filled by the appointment of Lord Brabourne as a director. Mr. H. L. Cripps retires in accordance with the Articles, but on account of ill-health his name is not submitted for re-election. On the outbreak of war, Mr. Rathenau, being a German subject resident in Germany, ceased to be a director. The Press has since reported the death of this gentleman. Mr. Brakhan resigned his seat on October 15th last. It is not proposed to fill these two vacancies.

Annual meeting: August 20th.

Puebla Tramway, Light and Power Co., Ltd.—According to the *Financial Times*, a meeting of the holders of the first mortgage thirty-year 5 per cent. gold bonds was recently held in London, at which a resolution sanctioning the modification of the rights of the bondholders was unanimously passed by votes representing upwards of two-thirds of the outstanding bonds. The effect of the resolution is to make the interest on the first mortgage bonds during the five years from January 1st, 1915, payable only if and when there are any earnings of the company available for the purpose; to enable the company to satisfy any interest unpaid at the expiration of five years by the issue of 5 per cent. non-cumulative income warrants at par; to suspend the operation of the sinking fund for a period of five years, and to extend the date of maturity of the bonds for five years from 1937 to 1942. The service of the prior lien bonds has been duly met.

L. & N.W. Railway Co.—This company held a special meeting last week, at which authority was given for the issue of new preference stock in place of consolidated stock authorised in 1901, and not now required. The issue is for £1,500,000 10-year redeemable preference stock, which is required for the completion of the Euston and Watford Electric Railway, and for other purposes. The price of issue is 96, and the interest 4½ per cent.

Oldham, Ashton and Hyde Electric Tramways Co., Ltd.—The directors have declared an interim dividend of 5 per cent. per annum on the ordinary shares for the past half-year, payable on the 16th inst.

Chelsea Electricity Supply Co., Ltd.—The directors have declared an interim dividend at the rate of 4 per cent. per annum, less income-tax, on the ordinary shares for the half-year, payable on September 15th.

Northampton Electric Light and Power Co., Ltd.—The directors have declared an interim dividend at the rate of 5 per cent. per annum (6d. per share) on the ordinary shares for the past half-year.

Telephone Development Co., Ltd.—The accounts for the year to June 30th show a surplus of £10,458, which it is proposed to carry forward.

Western Union Telegraph Co.—The report states that for the six months to June 30th the income was $24,019,260; expenses, including maintenance and reserves, $19,359,745; interest on bonds, $668,600; net income, $3,990,915, being an increase of $1,891,080 above the corresponding period of last year.

South Metropolitan Electric Light & Power Co., Ltd.—The transfer books and register of members will be closed from August 18th to 31st, 1915 (both days inclusive), for the preparation of warrants for dividends payable 31st inst. on the 7 per cent. cumulative first preference shares and 6 per cent. cumulative second preference shares.

Brompton and Kensington Electricity Supply Corporation, Ltd.—Interim dividends for the half-year to June 30th—On the ordinary shares at the rate of 9 per cent. per annum (less tax); on the preference shares at the rate of 7 per cent. per annum (less tax).

STOCKS AND SHARES.

TUESDAY EVENING.

An unusual number of interesting incidents have developed this week in the Stock Exchange markets; and although, generally speaking, the volume of business is meagre, in certain sections there has been something approaching activity. This is more particularly the case with the Marconi group; while upon Brazilian Tractions, and various of the companies—Canadian and American—engaged on war work for the Allies, a lot of attention has been focused by reason chiefly of the boom in industrial shares on the other side of the Atlantic.

On this side, we have seen nothing so sensational as that provided by the trans-ocean brigade in Wall Street. The London Stock Exchange does not deal, for instance, in Bethlehem Steel shares, the price of which has risen from 30, some fifteen months ago, to about 300 at the present day. Markets here are unacquainted with Electric Boats—whatever these may be—the price of which gyrates to the tune of 80 points a day, and seems to think nothing of it. Westinghouse issues are known on this side only through the medium of the British Westinghouse capital—the shares and debentures in the local company moving not at all what time their namesakes in America are undergoing all sorts of volatile fluctuations.

The boom over there, however, has certainly been instrumental in waking up the Marconi market, and also in stimulating business in New York Telephone bonds, as well as in a few other specialised departments. The market for the new War Loan has settled down to a steadiness and composure which have an effect in permitting public interest to switch on to other markets. Several of the big Home Railway companies are known to be contemplating fresh issues of capital, following the example of the London & North-Western and, some months ago, of the North-Eastern Railway.

Mexican stocks and shares show a reviving tendency. The Latin-American Conference, held a few days ago in Washington, has been adjourned to New York, where it is to be resumed when the spell of torrid weather is broken. A caustic observer remarked that in dealing with such hot stuff as Mexico, it might have been supposed that the warmer the weather, so much the more appropriate it was. There does seem to be a chance, however, of serious effort being made at last by the United States to explore the possible avenues leading to pacification, although, as we have pointed out previously, such talk in the past has so frequently proved abortive, from the practical point of view, that scepticism may be pardoned for demanding visual proof of good intentions before it invests money in Mexican securities.

At all events, Mexican Light & Power shares are in timid demand at a rise of about 5 points, and the Company's first mortgage bonds, which were marked down to 40, have steadied to their previous quotation of 45. Mexico Trams are better also, and it is possible to sell certain of the issues which for weeks past have been a drug in the market.

The cut in the dividend announced by the Brazilian Traction Co. was followed almost immediately by a vivid rise in the price of the common shares, which carried it to 51 before a slight reaction occurred which took it back to 49¼. By odd coincidence, the rise took place on the day following the declaration of the decreased dividend, from which it was inferred that there must have been bears who were only waiting for the news to be announced before they endeavoured to cover their tracks. In this supposition there was a reasonable amount of likelihood; but, as it happened, just about that time the Brazilian Government rather unexpectedly paid off some of its treasury bills, and this evidence of its financial position put fresh heart into the supporters of Brazilian issues in general. The company, as we have shown before, is doing well; and if it were not for the low rate of exchange, the 6 per cent. dividend could have been easily maintained. For the first five months of the company's current year, the aggregate net earnings of 18 million mils. showed an increase of 767,000 mils. above those of the corresponding period in the previous twelvemonth.

Most of the Latin-Canadian Power companies are making good money. The Alabama Traction announced that payment of its bond interest will be resumed next month, and the expansion of earnings is quite satisfactory. The Consolidated Gas, Electric Light & Power Co., of Baltimore, has a useful increase of $136,000 for the eleven months of the company's financial year, the total net earnings being nearly three million dollars. The Pennsylvania Water Co., the Shawinigan and the Mississippi River Power Companies are all doing better than they were a year ago. The market in most of the securities is firm, from the reflection of the strength in the War Specials to which reference has been already made. Business in the United States advances substantially month by month, but there is a good deal of deprecation, even in New York, of the gamble which the speculators have set going in the shares of American-Canadian armament and allied companies.

The most active market of all at the present time, after that in the War Loan, is in Marconis. American Marconis have been varying between a guinea and 17s. 6d., closing this (Tuesday) night at 20s. Each reaction brings in a fresh set of buyers, of whom it is claimed that the majority send orders

from the United States. The mere fact of the company not having paid a dividend in respect of the past year carries no weight with the present buyers. Those people who invested their money in American Marconis what time the shares were placed upon the market, must be thanking their lucky stars for the unexpected turn in fortune's wheel, particularly those who made the investment with borrowed money. Canadian Marconis have come into demand at 6s., and Spanish are about the same price. New York Telephone bonds rose a trifle to 96½, and have changed hands as high as 97½.

Beyond this Marconi excitement, there is nothing very cheering about telegraph stocks. The decline in Eastern Telegraphs continues, the ordinary having slipped back to 117. The 4 per cent. debenture stock, however, is a point harder at 81; and Anglo-American deferred recovered the ¼ which it lost last week. United River Plates have receded a little. The Western Telegraphs which have been recently on offer round about 11½ are being steadily absorbed. Electricity Supply shares are mainly firm, the only exception being Metropolitan ordinary, which fell to 2⅞. The reduction in the interim dividends has rendered the market a trifle unsteady as a whole, but there is not a great deal going on.

British Westinghouse preference and debenture have both given way, the latter shedding 2 points to 68. British Insulated ordinary, while nominally 11, could probably be bought in the neighbourhood of 10⅝; half-a-dozen sellers of small lots have appeared in a market unsupported by any buying orders, and those who wish to pick up shares at a low price might easily be able to do so with a bid below the figure quoted.

The Victoria Falls & Transvaal Power Co. has just issued an excellent report, showing an increased profit of £33,000. This enables the company to pay 8 per cent. on its preference shares for the year, which brings the dividend on these up to April 30th, 1914. The substantial sum of £106,000 is carried forward, so it seems obvious enough that it will not be very long before all the arrears are cleared off. The price of the preference is firm at 15s., and the ordinary are quoted at 4s. 6d.

The Adelaide Electric Supply Co. has issued a further letter to the holders of its 5 per cent. debenture stock, and a modification is suggested of the previous proposals—quoted here last week—with reference to the placing of the sinking fund on a 1 per cent. cumulative basis. Instead of this, it is now proposed to substitute 3 per cent. for 1 per cent., and the directors calculate that this would have the effect of redeeming the whole of the issue in 20¼ years, that is, slightly earlier than the due date of 1936. The root of the objection to the scheme seems to us to lie in the tampering at all with the trust deed, which should be kept inviolate. To admit the principle that trust deeds can be altered for any reason whatever is a dangerous excursion in finance; and, however excellent may be the reason for suggesting it, to our mind the principle should be held sacrosanct in the interests of public confidence in any such security.

The Armament group is a little more active, though without any corresponding movements being caused in prices. Rubber shares are good. The tone seems to have taken a change for the better; and although the florin shares standing round about par are still somewhat neglected, they will probably participate before long in the present demand for higher-priced shares in this market. The public disposition seems willing to buy more or less speculative shares yielding high rates, in order to mix with the War Loan, with its 4⅝ per cent. return, and thus by the selection to obtain about 6 to 7 per cent. on the money. As a pure investment, the War Loan is by far the most popular stock in the markets; and it may be of interest to the curious in such matters to learn that the weight of the scrip certificates which have been handed out within the past month—each individual certificate weighing about ¼ oz.—amounted in the aggregate to nearly twenty tons.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RETURNS.

Locality.	Month ended (4 wks.)	Receipts for the month.		No. of weeks.	Total to date.		Route miles open.	
		£	£		£	£		Inc.
Blackpool-Fleetw'd	July 31	5,001	−1,236	30	17,842	− 3,920	8	..
Bristol	„ 30	40,448	+ 669	31	280,932	+21,154	30·5	..
Chatham and Dist.	..	..	..	..	..	..	..	..
Cork	„ 29	2,195	− 95	30	14,829	− 302	54·25	..
Dublin	„ 30	25,636	−1,534	30	182,059	+ 5,805	9·89	..
Hastings	„ 29	4,349	− 725	..	..	− 1,957	19·8	..
Lancashire United	„ 21	7,687	+ 743	29	49,043	+ 1,154	42	..
Llandudno-Col. Bay	„ 30	1,998	− 409	35	10,058	+ 948	6·5	..
Tyneside	„ 28	2,629	+ 93	4	2,404	+ 225	11	..
Anglo-Argentine ..	Aug. 5	203,783	−13,937	30	1,583,027	−149,203	..	..
Auckland	June 30	19,139	+ 116	52	267,248	+ 914	25·42	1·06
Calcutta	July 31	17,917	− 734	..	..	− 6,478	..	..
Kalgoorlie, W.A. ..	May	3,269	..	21	13,472	..	..	..
Madras	July 17	4,017	+ 26	28	24,994	− 195	..	..
Montevideo ..	July	25,161	−1,256	39	251,853	−31,910	..	..
Dublin-Lucan Rly.	July 30	676	− 95	4	676	− 96	7	..

SHARE LIST OF ELECTRICAL COMPANIES.

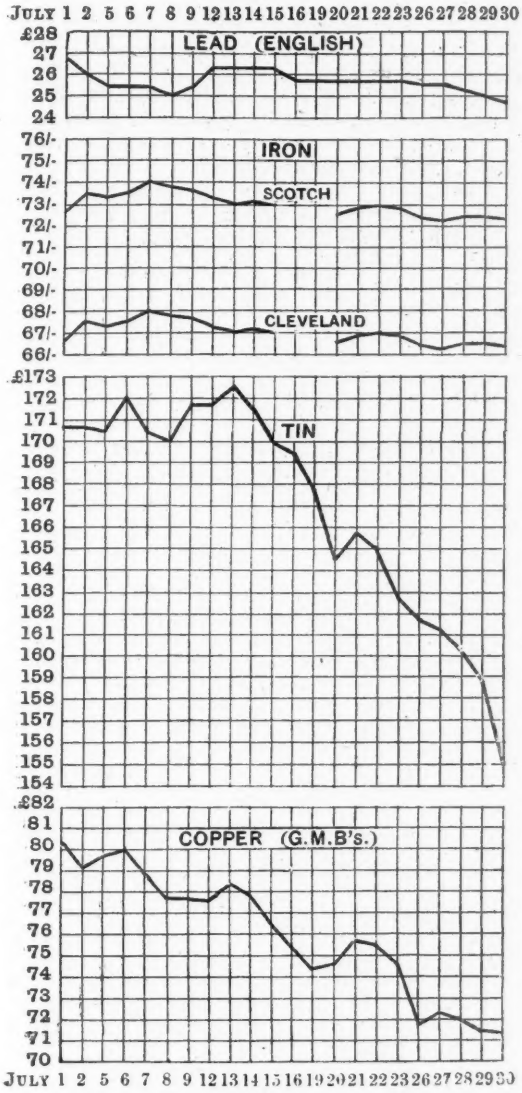
	Dividend, 1914.	Price Aug. 10, 1915.	Rise or fall this week.	Yield p.c.
Home Electricity Companies.				
Brompton Ordinary	10	8	—	£6 5 0
do. 7 per cent. Pref.	7	7¾	—	4 10 4
Charing Cross Ordinary	5	4	—	6 5 0
do. do. do. 4½ Pref. ..	4½	4	—	5 12 6
do. do. City Pref.	4½	3⅞	—	5 16 2
do. 4 Deb.	4	80	—	5 0 0
Chelsea	5	4½	—	5 11 1
do. 4½ Deb.	4½	88	—	4 17 10
City of London	9	13	—	6 18 6
do. do. 6 per cent. Pref. ..	6	11	—	5 9 1
do. do. 5 Deb.	5	100	—	5 0 0
do. do. 4½ Deb.	4½	85	—	5 6 0
County of London	7	10½	—	6 13 4
do. do. 6 per cent. Pref. ..	6	10½	—	5 14 3
do. do. 1st Deb.	4½	90	—	5 0 0
do. do. 2nd Deb.	4½	85	—	5 6 0
Kensington Ordinary	9	6¾	—	6 18 6
London Electric	4	1⅝	—	8 8 4
do. do. 6 per cent. Pref. ..	6	4¾	—	6 6 4
do. do. 4 Deb.	4	80	—	5 0 0
Metropolitan	8½	2⅞	− ⅛	6 1 9
do. 4½ per cent. Pref. ..	4½	3¾	—	6 0 0
do. 4½ Deb.	4½	90	—	5 0 0
do. 3½ Deb.	3½	70	—	5 0 0
St. James' and Pall Mall	10	7	—	7 0 0
do. do. do. 7 per cent. Pref.	7	6¼	—	5 12 0
do. do. do. 3½ Deb.	3½	70	—	5 0 0
South London	5	3	—	6 13 4
South Metropolitan Pref.	7	1⅛	—	6 4 5
Westminster Ordinary	9	7	—	6 8 7
do. 4½ Pref.	4½	4⅝	—	4 17 4
Telegraphs and Telephones.				
Anglo-Am. Tel. Pref.	6	97	—	6 3 6
do. Def.	1½	21¼	+ ¼	7 1 2
Chile Telephone	8	6¾	—	5 18 5
Cuba Sub. Ord.	5	8¼	—	6 1 8
do. Pref.	10	15	—	6 13 4
Eastern Extension	7	11	—	*7 5 6
do. 4 Deb.	4	73	—	5 2 7
Eastern Tel. Ord...	7	117	− 3	*6 17 6
do. 3½ Pref.	3½	70	—	5 0 0
do. 4 Deb.	4	81	+ 1	4 19 0
Globe Tel. and T. Ord.	6	9½	—	*7 4 4
do. Pref.	6	10	—	6 0 0
Gt. Northern Tel.	22	33	—	6 13 4
Indo-European	65/-	60	—	6 10 0
Marconi	10	2 3/16	+2/-	4 18 3
New York Tel. 4½..	4½	96⅞	− ⅛	4 13 3
Oriental Telephone Ord.	10	2	+ ⅛	5 0 0
do. Pref.	6	1⅛	—	5 6 8
Tel. Egypt Deb.	4½	80	—	5 0 0
United R. Plate Tel.	8	5½	− ¼	*8 6 6
do. Pref.	5	4¾	—	5 2 7
West India and Pan.	1	1⅛	—	8 17 9
Western Telegraph	7	11½	—	*6 19 0
do. 4 Deb.	4	81	—	4 16 5
Home Rails.				
Central London, Ord. Assented ..	4	73	−1	5 8 1
Metropolitan	1¾	23½	—	5 6 5
do. District	Nil	14	—	Nil
Underground Electric Ordinary ..	Nil	1⅛	—	Nil
do. do. "A"	Nil	6/-	—	Nil
do. do. Income ..	6	74	−1	*9 5 0
Foreign Trams, &c.				
Anglo-Arg. Trams, First Pref. ..	5½	4	—	6 17 6
do. 2nd Pref.	5½	8½	—	7 17 2
do. 4 Deb.	4	73	−2	5 9 7
do. 4½ Deb.	4½	75	—	6 0 0
do. 5 Deb.	5	75	—	6 13 4
Brazil Tractions	4	49⅛	+4	7 1 5
Bombay Electric Pref.	6	10½	—	5 16 10
do. 4½ Deb.	4½	90	—	5 0 0
Mexico Trams	Nil	33	—	Nil
do. 5 per cent. Bonds ..	—	50	—	Nil
do. 6 per cent. Bonds ..	—	85	+5	Nil
Mexican Light Common	Nil	25	+5	Nil
do. Pref.	Nil	30	—	Nil
do. 1st Bonds	—	45	—	—
Adelaide Sup. 6 per cent. Pref. ..	6	6	—	6 0 0
do. 5 Deb.	5	99	—	5 1 0
Manufacturing Companies.				
Babcock & Wilcox	14	2¾	—	6 4 5
British Aluminium Ord.	5	1 3/16	—	4 14 1
do. Pref.	6	18/8	—	6 9 9
British Insulated Ord.	15	11	—	6 13 4
do. Pref.	6	6	—	5 0 0
British Westinghouse Pref.	7½	31/6	−2/-	9 10 6
do. 4 Deb.	4	68	−2	5 14 4
do. 6 p. lien	6	100	—	6 0 0
Callenders	15	11	—	6 16 4
do. 5 Pref...	5	4¾	—	5 5 3
do. 4½ Deb.	4½	95	—	4 14 9
Castner-Kellner	15	8½	—	4 12 6
Edison & Swan, £3 pd.	Nil	11/6	—	Nil
do. do. fully paid	Nil	1	—	Nil
do. do. 4 Deb.	4	60	—	6 13 4
do. do. 5 % Deb.	5	60	—	8 6 8
Electric Construction	6	12/	+6d.	10 0 0
do. do. Pref.	7	1	—	7 0 0
Gen. Elec. Pref.	6	9¾	—	6 3 1
Henley	20	14	—	*3 3 8
do. 4½ Pref.	4½	4¾	—	4 14 9
do. 4½ Deb.	4½	95	—	4 14 9
India-Rubber	5	8¾	—	5 14 3
Telegraph Con.	20	31	—	7 15 0

* Allowance made for dividends being paid free of income-tax.

Pacific Gas and Electric Co.—The accounts for the year 1914 show a gross operating revenue of $16,912,688, an increase of $1,043,682, while the net income rose by $1,435,451 to $8,306,582. The available balance, however, is only $992,621 higher at $3,645,666. After deducting dividends and allowances for depreciation, a balance of $1,476,320 is carried forward.—*Financier.*

METAL MARKET.

Fluctuations in July.



The Glasgow Iron Market was closed on July 16th and 19th.

U.S. Central Station Users of Electric Vehicles.—A recent issue of the *Central Station*, New York, contains tabulated data referring to the use of petrol and electric vehicles by 250 central stations in the States, from which it appears that 328 of the former and 864 of the latter are in use in the stations enumerated. Foremost in the list are the Commonwealth Edison Co., Chicago, with 114 electrics, and the New York Edison Co., with 130 electrics, neither company showing any petrol cars in use. The Boston Edison Co. operates 56 electric and 3 petrol cars; the Rochester Railway and Light Co. has 53 electric cars and 1 petrol car; the Philadelphia Electric Co. has 40 electric and 26 petrol cars; the Baltimore Consolidated Co. has 27 electric and 8 petrol cars; the Detroit Edison Co., 25 electric and two petrol cars; the St. Louis Union Co., 20 electric cars only; and so on, these being the principal station users in the list.

King Albert's Civilian Hospital Fund.—An urgent appeal is made for assistance for the civil population of the portion of Belgium still held by its heroic people, which presents a picture of overwhelming distress. It is proposed to establish small movable hospitals which can be quickly set up in villages as necessity arises, and managed as self-contained units. The ground over which the fund will work must be traversed by our troops as they advance, and it is imperative that it should be quickly restored to a healthier and more sanitary condition. Cheques may be made payable to "The London County and Westminster Bank," crossed "King Albert's Civilian Hospital Fund," and sent direct to the Bank at 62, Victoria Street, S.W. Contributions of clothing, boots, linen, medical stores, sheets, blankets, bedding, household requirements, foodstuffs, &c., will be gratefully received at the Hospital Depôt, care of Harrod's Stores, 116, Brompton Road, S.W.

THE FUTURE OF EXPORT TRADE.

After a year of war, and the prospect of hostilities still being continued for a further period, the length of which it would be impossible to specify with any degree of certainty, the question of the future of the export trade of some of the nations which are engaged in the present contest has had provisionally to be subordinated to the absolute necessity for meeting requirements in the matter of adequate supplies of arms and ammunition, which have been shown to be more essential than ever under existing conditions of position fighting, in order to bring the war to a successful conclusion in favour of the Allies as soon as possible. Under these circumstances it is comprehensible that while the general object of capturing a large portion of the export trade hitherto carried on by Germany and Austria-Hungary is not by any means being lost sight of, some relaxation of effort must have occurred in view of the more important problems which await a satisfactory solution at the present time. In this connection it has to be borne in mind that the financial conditions in several of the Republics of South America—one of the great markets which was held in prospect for development—had become extremely critical before the outbreak of the European war, and the situation in these countries has been aggravated indirectly by the war, whilst nations in other parts of the world are also suffering indirectly from the world conflagration. Naturally, the cultivation of export trade under existing conditions is a matter of difficulty to some of the belligerents, and quite impossible to the others.

But even the North Americans (United States), who, less than 12 months ago, were equally as zealous as British firms in the desire to capture German export trade, particularly in South America, have been greatly disillusioned with regard to South American markets, notwithstanding that the United States have retained their freedom of activity through not being involved in the war as belligerents. Instead of increasing their export trade to the whole of the South American Republics, and to British, Dutch and French Guiana, the figures issued by the Department of Commerce at Washington are reported to show a decrease of £4,400,000 in the value of the exports to those destinations in the financial year ended with June, 1915, as compared with the previous year, whereas the imports from those countries increased by £1,000,000 as compared with the year 1913-14. The imports into the United States from Canada experienced a still greater advance, whereas the value of the exports to Canada underwent an enormous diminution.

If then the efforts put forth by British firms to expand their export trade in the past 12 months have not been crowned with that particular measure of success which was originally expected, the explanation lies chiefly in the financial situation of transmarine countries all over the world as affected indirectly by the war, and we have at least the consolation of knowing that North Americans, although not directly hampered by the war, have hitherto failed to make any material progress in the South American markets notwithstanding the swarms of travellers who were sent out expressly to get into touch with possible buyers. It is, however, less with the past than with the future that we are concerned at the present time, and the same observation applies to France, Russia, Italy, and Germany and Austria-Hungary; Belgium, Serbia and Turkey do not come into consideration for the time being. Now each of the allied countries is determined to render itself independent of enemy countries as far as is possible in regard to manufactures and other products which were previously imported from them. But when we reflect on the export side of the problem, we find that whilst almost complete unanimity prevails in Great Britain as to our future possibilities, a diversity of opinion exists both in France and Germany, where both pessimists and optimists give expression to their beliefs. In France, where certain commercial associations have been formed recently or developed from a pre-war period, the formation of export banks is advocated, which would enable exporters to ascertain the solvency of foreign customers and regulate payments according to the customs and in the currency of

the countries concerned. The suggestions made by M. E. Morel, vice-president of the Lyons Chamber of Commerce, best summarise the opinions of many circles. He states that Frenchmen must (1) learn to know foreign customers, for they do not know them; (2) send out travellers who speak the language; (3) manufacture products required by customers instead of forcing upon them French products; (4) offer the goods freight and duty free, and accept payment in the currency and on the conditions prevailing in the foreign market; (5) deliver the goods punctually; (6) learn the art of packing the goods in a faultless manner; (7) agree cautiously to the usual system of credit abroad; and above all (8) desire to conquer foreign markets. Whilst these objects are praiseworthy from the French point of view, there is another side of the question to be dealt with before the French can hope to succeed in the former aims. This particular side refers to the setting in order of French domestic affairs, to which M. Victor Cambon, the well-known economist, recently devoted a series of lectures, which were delivered before the Association of Engineers in Paris. The lecturer stated that the goal would be reached with France exhausted of men and money, the lack of which would be most seriously felt, apart from the absence of the hundreds of thousands of Belgian, German, and Italian workmen who were employed prior to the war. The financial difficulties, he declared, would be considerable, and apart from those now engaged on Government orders, most of the industrial companies would be half ruined, some through the stagnation in business and the others through the destruction of their works. And yet thousands of buildings and works will have to be rebuilt in part of the country, concurrently with the reconstruction of railways, roads, underground water and sewer services, and other public installations of different kinds. M. Cambon, who is far from being sanguine as to the future, asks, if Germany becomes exhausted and ruined, what can the Allies do in regard to an indemnity with a country which has sacrificed its last pfennig on the continuation of the war?

Turning now to Germany, where the future of the export trade is equally occupying increasing attention, a Mr. J. Marz discusses the problem in a pamphlet which has just been published in Berlin. He remarks that pessimists declare that the exasperation created in enemy countries through the war must produce a feeling which will last for years after the conclusion of peace, and that it will induce those countries to adopt far-reaching measures for protecting themselves against German goods, facilitated by the boycotting movement and the activity of the associations formed for this purpose. Although the author does not assume that all these proposals will be carried into effect, he considers that the danger of such a propaganda in regard to the renewal of commercial relations should not be underestimated. As far as Great Britain in particular is concerned, it appears that opinions of German manufacturers and merchants are divided. On the one hand serious apprehensions are entertained, while on the other it is contended that British firms will resume their long-standing trading relations with their former German friends, especially in so far as they bring business to the former. Even the most embittered economic war, in the opinion of the author, will be unable to secure the renunciation of the principles which regulate international trade—the law of supply and demand—and the participation of Germany in the world's markets has so strengthened the position of that country, that it is submitted that it cannot be shaken even through the complications of the world war. In addition, it is held that the great specialisation of German industry, and the independent inventions on the basis of economy, industry, and technics, would not allow of her share in supplying the world markets being appropriated by other countries without much difficulty, whilst Germany herself requires certain raw materials, semi-finished materials, and manufactures for which substitutes could not be provided at once in neutral countries. The author, therefore, concludes that the assumption is justified that after the war commercial relations between the belligerent countries will probably soon have to be resumed, and that Great Britain, France and Russia will sell goods to Germany, and in turn will have to procure commodities from the latter country.

It is reasonable to assume that when a period of peace once again prevails in Europe, the resources of France and Belgium will be very largely, if not entirely, absorbed by the national requirements in the direction of the reorganisation and rehabilitation of the districts which have been devastated by the enemy, unless it should prove to be possible to carry out these works gradually and concurrently with the driving out or withdrawal of the hostile armies; we are, however, rather inclined to accept the opinion of M. Victor Cambon, which, if it should prove to be correct, would imply delay in the execution of the programme outlined by the vice-president of the Lyons Chamber of Commerce.

In the case of Germany the situation as it affects Great Britain is extremely delicate. On one point, however, there can be no shadow of doubt, with the present terrible results of the war before us—that whatever we can produce for ourselves or, failing that, whatever we can import from countries other than enemy countries, we shall not seek to procure from Germany or Austria-Hungary in the future. But, in other respects, it will scarcely be possible to avoid an interchange of trade. It is, however, particularly in the oversea export markets that the commercial contest will become keen—keener by far than in recent years—and we must necessarily steadily prepare ourselves by all means in our power for the great economic struggle of the future. It is doubtless correct that the finances of Germany will by that time have become so greatly exhausted that it will no longer be possible for that country either to produce as economically as in the past, or to continue the long credits which have been the custom in oversea countries; but we must not place too much confidence in this assumption, or in the supposition that neutral countries, on account of Teutonic atrocities, will not resume their former business relations with Germany when the war is over. All we have to do is to be in a state of readiness to meet the great trade contest, and the preparations which are in progress for this purpose should be continued as vigorously as is possible under the conditions prevailing at the present time, and those which may be expected to exist in the period which lies before us.

POWER SUPPLY TO THE RAND MINES.

The latter part of Mr. Bernard Price's presidential address to the South African Institute of Electrical Engineers, delivered in May last, dealt with the above subject, and comprised a description of the main features of the Power Co.'s business and a comparison of its characteristics with those of other typical schemes. The following is an abstract of his remarks:—

The business is controlled by two companies, the Victoria Falls & Transvaal Power Co., Ltd., and the Rand Mines Power Supply Co., Ltd., the latter company being a subsidiary of the former, and the combined system being operated and managed by the Victoria Falls & Transvaal Power Co., Ltd. For present purposes, therefore, the business may be treated as one complete scheme, and as such it ranks as one of the largest in the world.

The following general description of the system is necessary for a proper appreciation of the statistics which follow. Typically the scheme is one which supplies a single industry, comprising a relatively small number of relatively large consumers scattered over a compact area. The area takes the form of a narrow strip about 45 miles long, stretching from east to west. There are three generating stations along this strip, namely, Brakpan, at the far eastern end, Rosherville at about the centre, and Simmerpan between the two. There is also an outlying station on the Vaal River at Vereeniging, situated about 35 miles due south of Johannesburg, which feeds into the area at Robinson Central, a point about five and a half miles west of Rosherville. It will be seen, therefore, that there are four points of supply along the narrow area, and as the density of the load is greatest in the neighbourhood of these four points, the average distance of distribution is small compared with that which would be necessary in many schemes.

Distribution is carried out at 20,000 volts overhead or underground over all sections of the area, excepting that in the neighbourhood of Simmerpan and a small portion of that fed from Brakpan, where the pressure is 10,000 volts. The choice of these relatively high pressures has been determined by considerations of economy in capital cost of lines, cables and switchgear, rather than of pressure drop. The main transmission system virtually consists of overhead inter-connectors at 40,000 volts between the four points of bulk supply and of two similar lines running west from Robinson Central to

feed the relatively small section of the load at the extreme western end of the area. The power generated at Vereeniging is transmitted to Robinson Central at 80,000 volts. The railage charges on coal from the Middelburg colliery district (which lies some 70 miles to the north-east of the area of supply) are heavy, and the supply of cooling water within the area is restricted. It has, therefore, proved advantageous to expend capital upon transmission lines from an outlying station situated favourably as regards water supply and in close proximity to a colliery, and to transmit energy therefrom in the form of electricity rather than in the form of fuel. Under these conditions, the stations at Vereeniging and Brakpan, which are nearest to the source from which their fuel is drawn, are operated at the highest possible load factor, and Simmerpan and Rosherville are left to take the remainder of the load at a lower load factor. The following table gives particulars of the demand and consumption of the three classes of consumers served by the companies:—

PARTICULARS OF CONSUMERS CONNECTED TO THE POWER COMPANIES' SYSTEM.

Class of consumer.	No. of consumers.	Aggregate of non-simultaneous maximum demands at points of delivery, January, 1915.		Units consumed per annum.	
		KW.	Percentage of total.	Millions of units.	Percentage of total.
Mining	65	95,000	98·0	514·5	99 00
Industrial ...	8	1,100	1·1	2·8	0·55
Bulk supplies to municipalities...	5	900	0 9	2 3	0 45
Totals ...	78	97,000	100	519·6	100

It will be noted as an outstanding feature that no less than 99 per cent. of the business is represented by supply to the mining industry.

Figs. 1 and 2 give a general idea of the type of supply taken by such mining consumers as have completely electrified their mine. Fig. 1 is for a mine working single shift and fig. 2 for one working double shift. The compressor load for this latter mine is probably somewhat higher than that for an average case, but otherwise the charts may be considered typical. I shall return to these diagrams later, but in the meantime it may be noted that the load in both cases is at its highest between the hours of 8 a.m. and 4 p.m. in the day time. Fig. 3 shows certain load curves of the power companies' system, including only the electric business proper. As you are aware, the Rand Mines Power Supply Co., Ltd., also supplies upwards of two million tons of compressed air per annum at a gauge pressure of about one hundred pounds per square inch, and a portion of this air is compressed by means of electrically-driven compressors at Robinson Central. As I am now dealing solely with the electric power actually sold as such, the power used for driving the power companies' compressors has been excluded. The curves shown on the left-hand side of fig. 3 have been plotted from half-hourly readings of the units sent out from generating stations on Friday, January 5th, 1915, and Sunday, January 7th, 1915, whilst the week-day curves shown on the right represent the average of six normal week-days during January, 1915, and January, 1912, the Sunday curve being an average of four Sundays in January, 1915. All three curves on the right have been obtained from hourly readings, and the curves on the

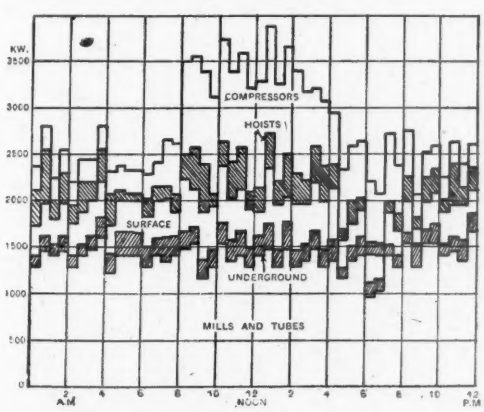


FIG. 1.—TYPICAL SINGLE-SHIFT MINE LOAD.

left have been included merely to show the half-hourly fluctuations which occur on a normal day. A similarity between the shape of the load curves of typical consumers and of the power companies' system will be at once apparent, this similarity being due to the fact that the cycle of operations is virtually the same on all mines. Whilst no doubt a certain number of consumers work double shift, this does not influence the fact that the periods of maximum demand for all consumers overlap. The shape of these curves is of first importance, because upon it depends to a very large extent the cost of furnishing the supply, and it may therefore be of interest to carry the analysis somewhat further.

It will hardly be necessary to explain that the cost of producing and furnishing a supply of electric power is mainly dependent upon two factors, namely: (a) Capital and other

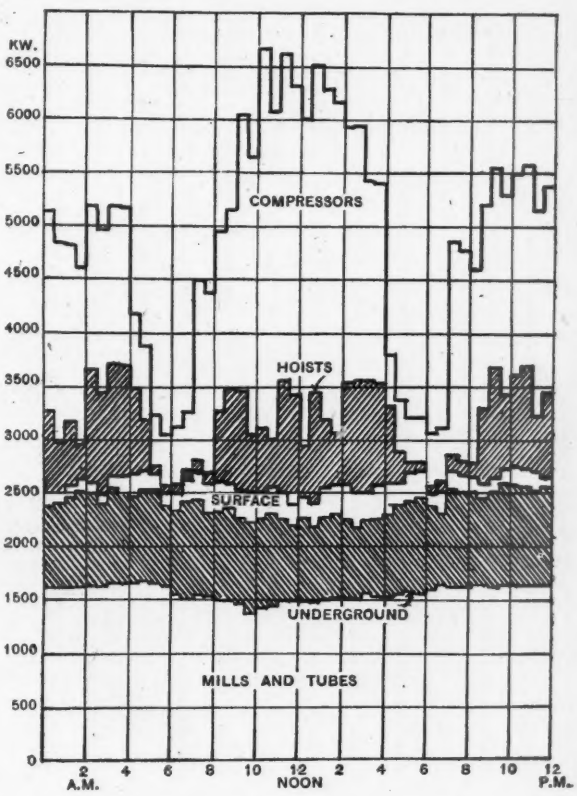


FIG. 2.—TYPICAL DOUBLE-SHIFT MINE LOAD.

fixed charges, which are dependent upon the capacity of the plant and system required for meeting the maximum rate of supply; (b) running charges. The first of these two charges varies inversely as the load factor, whilst the second item, though also dependent upon the load factor, to a very considerable extent, is not directly inversely proportional to the load factor. The load factor of the combination of a number of individual supplies may be influenced by both the load

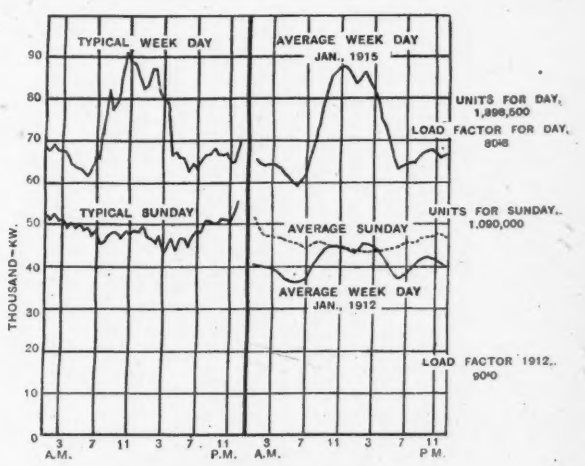


FIG. 3.—TYPICAL DAILY LOAD CURVES.

factor and the diversity factor of the individual supplies, and the inter-relationship between these two factors is not always easy to follow. The complexity of the subject is, however, reduced when dealing with a very large system such as that under consideration, because the effect of all short-time fluctuations may then be ignored. Standard plant of the type and size now in use, when fully loaded by the hourly average rate of supply, is capable of meeting the short-time peaks without undue strain. Large generators and transformers

absorb a considerable quantity of heat for a relatively small increase in temperature, and consequently respond but sluggishly in temperature to the fluctuations of heat generated within them. Similarly the boiler plant has a considerable storage capacity for energy, and one of the special characteristics of a steam turbine is its ability to meet heavy overloads without distress. It may, in fact, be said that as the size of a system increases the percentage short-time variation in load tends to decrease, whilst the ability of the plant to deal with such variations increases owing to the increase in the size of units of plant which can be usefully employed. Although some of the winders in this district are unusually large, the largest of them represents a momentary peak of only about 3½ per cent. of the system peak, and at times when two such winders happen to synchronise the variation will be only about 7 per cent., lasting for a couple of minutes at the most. The average rate of supply taken over an hour is therefore a satisfactory guide as to the amount of plant required for meeting the service, and for this reason statistics regarding loading are taken on the basis of units per hour. I will refer to load curves made out on this basis as "Smoothed Load Curves," that is, curves on which the short-time fluctuations have been averaged over an hour. This basis is very convenient in every-day practice, because integrating instruments have to be provided in any event for measuring station output and consumers' consumption, and such instruments are very reliable and accurate. Moreover, it is a simple matter to provide attachments to the sub-station integrating instruments which will record on a dial the maximum of the hourly consumptions, thus rendering it unnecessary to record each of the many hundred hourly figures, and to then select the maximum therefrom. These attachments operate on the same principle as a maximum and minimum thermometer. By means of a clock the mechanism of the integrating watt-hour meter is brought into gear with the attachment at a given time, and thereafter for one hour the movement of the meter turns the pointer on the dial of the attachment round the scale of units. At the end of an hour the clock resets to zero the mechanism which has been actuating the said pointer, leaving the pointer itself where it is, and this process is repeated during the second hour, and so on. If the number of units consumed during one of the subsequent hours is greater than that during the first hour, the actuating mechanism reaches the pointer before the end of the hour and moves it further round the scale, so that it may register the greater consumption. The position of the pointer at any given time, therefore, shows the maximum of the consumptions taken during successive hours since the time when the pointer was last set back to zero by hand. The installation of such apparatus at every point of supply throughout the system enables accurate and complete data to be obtained regarding the load factor and diversity factor of the smoothed curves of the various supplies.

The diversity between any given selection of supplies may be considered as being of two independent types. Firstly, there is such diversity as may be due to a fundamental difference in the shape of the smoothed load curves of component supplies, having due regard to time ("fundamental diversity"); and, secondly, there is the diversity which is due to irregularities in that portion of each of the smoothed load curves which falls within the period of the maximum demand on the system ("general diversity"). In most large schemes the general shape of the load curves of individual supplies differs more or less for the several classes of consumer served on account of differences in the type of business carried on, and differences in the cycle of operations peculiar thereto. In other words, most schemes derive considerable benefit from fundamental diversity between the demands made by several different classes of consumers, whereas there is virtually no fundamental diversity on the system of the power companies in this district at the present date. The diversity here may be attributed entirely to general diversity, that is, to the inter-leaving of the fluctuations on the smoothed load curves of individual consumers during the period of maximum demand of the resultant supply. Reference to figs. 1 and 2 will show, however, that this general diversity will not be inconsiderable, as the amplitude of the hourly fluctuations on the smoothed load curves of individual consumers during the period of the peak is by no means small. The clearest way to express diversity is to take the ratio between the aggregate of the individual maximum demands (which are non-simultaneous), and the maximum aggregate of simultaneous individual demands taken at the points of delivery in each case. The aggregate of the non-simultaneous maximum demands is arrived at by adding together the readings of the maximum demand attachments of the sub-station watt-hour meters above described. The maximum aggregate of simultaneous individual demands cannot be conveniently measured at points of delivery which are scattered all over the area, but is arrived at by selecting the maximum number of units sent out from generating stations during the successive hours of the period in question, and then correcting this figure for loss in transmission and distribution. In fig. 4 statistics are given regarding the load factor, diversity factor, and losses for the power companies' system in the form of monthly figures extending over the last four years. It will be observed that the diversity factor (which is calculated as above described) varies between 1.2 and 1.25, which means that 20 to 25 per cent. more plant would have been required to meet the supplies if there had not been diversity between the hourly humps and hollows on the shape of the smoothed curves of the individual supplies. This factor, being obtained from smoothed curves only, eliminates the very much greater amount of diversity which must exist between the short-time fluctuations on the charts

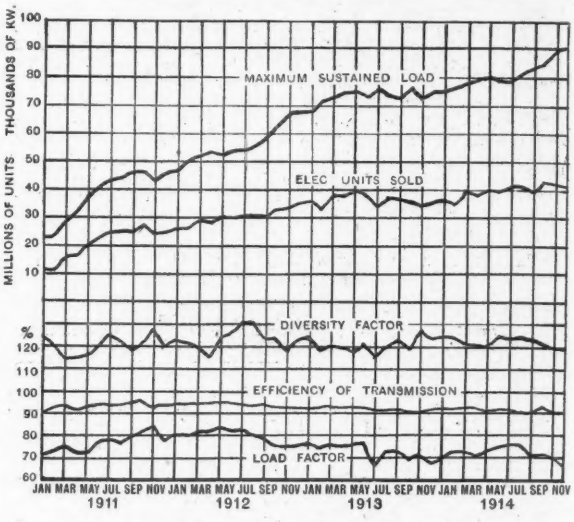


Fig. 4.—Statistical Curves, Power Co.'s System.

obtained from curve drawing watt-meters. Such short-time fluctuations of the individual supplies are almost entirely due to the winders and haulages, and there are so many of these that very complete diversity takes place between them. The following table is interesting in this connection:—

Particulars of Winders Connected to the Power Companies' System.

Type of winder.	No. of winders.	Total installed capacity at continuous rating. H.P.	Average size at continuous rating. H.P.
Underground winding—			
A.C. winding motors ...	62	17,600	284
Surface winding—			
A.C. geared hoists	52	21,300	430
A.C. direct coupled hoists ...	10	12,700	1,270
Ward Leonard hoists ...	19	21,400	1,130
Totals	143	74,000	517

Continuous rating of largest Ward Leonard hoist about 5,000 H.P
Present momentary peak demand for ditto ... ... 9,000 H.P
Continuous rating of largest A.C. hoist ... ... 1,600 H.P

The above figures are specification ratings.

It will be noted that the system supplies no less than 143 winders (exclusive of haulages) aggregating 55,000 KW. at continuous rating. I do not think there is another scheme in the world which is supplying such a large capacity of this class of load. An intermittent supply of this type, involving as it does a very heavy momentary peak, which is often taken at relatively low power factor, is generally considered an unfavourable type of supply from the power companies' point of view, but this is only partially true. The reduction in power factor is undoubtedly most objectionable, but whereas a small number of such loads connected to a relatively small system would necessitate an increase in both the kilowatt and K.V.A. capacity of the momentary system plant for the sole purpose of meeting the momentary demand caused by synchronisation of the individual peaks; and whereas such loads would prejudicially effect the voltage and speed regulation of the system, a large number of such supplies connected to a large system, diversify very fully and have no prejudicial effect other than the reduction in power factor.

It may, in fact, be said that having once connected a few winders to a large system, it is beneficial so far as the diversity and regulation of the system is concerned, to add as many as possible. Under the conditions obtaining on the power companies' system to-day, the addition of a new large winder has no more effect upon the load curve of the system than the addition of a load having a smoothed curve similar to that of the winder. In fig. 5 an attempt has been made to show how the power companies' system load curve is built up. To do this accurately would involve the collection of an enormous amount of data; in fact, it would be necessary to obtain the actual smoothed load curve of each section of each component supply. A sufficiently close approximation can, however, be obtained by assuming certain diversity factors for the several components and by calculating the maximum demand from particulars of the total installed capacity of each class of plant on consumers' premises. Certain assumptions have also been made with regard to the shape of the load curves of individual sections of the supply, but I think the following conclusions may be safely drawn from this diagram: (1) If it were not for the load taken by

compressors and winders the system load curve would be very nearly flat and would probably have a week-day load factor of over 90 per cent. As a corollary the miscellaneous load on the surface and underground has a relatively high load factor. (2) There is a pronounced valley in the system load curve between the two shifts on the mines, that is at about 6 a.m. and 6 p.m. The relatively small rise in the load after 6 p.m. and until 6 a.m., as compared with the large rise between 6 a.m. and 6 p.m., shows that a large majority of the mines now work single-shift. This point is brought out

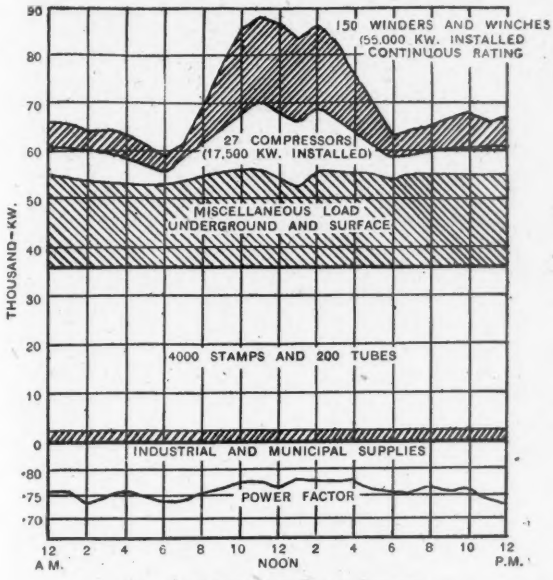


FIG. 5.—COMPOSITE LOAD CURVES.

very clearly when comparison is made between the week-day load curves shown on the right-hand side of fig. 3 for 1912 and 1915. In January, 1912, the height of the night peak (taken from the mean of the bottom of the two valleys) is about 65 per cent. of the height of the day peak taken from the same point, whereas in 1915, three years later, the percentage had fallen to about 25 per cent.

This increase in the proportion of day peak to night peak is largely due to many mines changing from double to single-shift since 1912.

It has been mentioned that the load factor of a combination of supplies may depend upon both the load factor and the diversity factor of the components. Fig. 5 shows this; each supply to stamps and tube mills has a week-day load factor of close on 100 per cent., due to the high load factor of each individual mill and tube mill motor. In this instance diversity plays practically no part. The winders and compressors, on the other hand, have a relatively low load factor, but as their smoothed load curves are similar and overlap, the diversity is confined to "general diversity," and this is, therefore, a case where some benefit, but not much, is derived from diversity. The remainder of the load, however, is made up of a multiplicity of miscellaneous loads underground and on the surface, the operation of which in many cases is not governed by any particular schedule. No doubt some of the loads have high load factors individually, but, on the other hand, a large number have very low load factors and diversify greatly on account of the fact that the consumer's business is in progress night and day, rendering it possible for intermittent work to be spread over the twenty-four hours. It must be borne in mind, nevertheless, that the major portion of this diversity takes place between motors on a given mine, and there will not, therefore, be very much diversity between the smoothed load curves of the miscellaneous supplies of different mines.

The week-day load factor of the system for January, 1915, as calculated from the six days' average curve in fig. 3, is 80.6 per cent., and it will be observed that the monthly load factor as shown in fig. 4 now varies between 70 and 75 per cent., depending largely on the proportion which the number of Sundays bears to the number of week-days in the month. In January, 1912, the week-day load factor calculated from the curve in fig. 3 is 90 per cent., and the monthly load factor at that date as shown in fig. 4 was about 80 per cent.

If the load factor had remained at this figure of 80 per cent. instead of falling to the present average of 72.5 per cent., the plant capacity required on the power companies' system would to-day be reduced by about 8,500 KW., together with a corresponding reduction in the margin of spare plant of 2,100 KW., making a total reduction of 10,600 KW., so that one large generating set could have been dispensed with, and this shows, roughly, the effect of the adoption of single-shift working on the power companies' electric business.

The position as regards load factor and diversity factor may, therefore, be summed up by saying that the load factor of the power companies' system is high because each and every consumer has a relatively high load factor. As compared with most schemes, diversity plays a very minor part.

Fig. 5 also shows the variation in the power factor of the total electric load on the system during a typical week-day, including the supply to the electrically-driven compressors at Robinson Central.

The motors which drive these compressors are of the synchronous type, and are over-excited to take leading current.

The power factor shown on the curve does not, therefore, represent that due solely to the loads demanded by consumers, but it will be observed that under the conditions obtaining, the figures average about 77 to 78 per cent. during the peak.

The third curve in fig. 4 shows the variation in the efficiency of transmission and distribution during the last four years.

The factor is the ratio which the total number of H.T. units delivered to sub-stations bears to the total number of units sent out from generating stations during each month.

Although the units taken by consumers are measured at the L.T. bus-bars in the sub-station, 2 per cent. is allowed to the power companies in the case of mining consumers to cover transformer losses and the overall efficiency down to the L.T. meters in sub-stations is, therefore, about 2 per cent. less than the figures shown on this curve. The efficiency has fallen off slightly, and now averages about 92 per cent. (about 90 per cent. on the L.T. bus-bars). This is due to the increasing output generated at the distant station at Vereeniging; the fluctuations are accounted for by changes in relative loading of the stations, and consequently in the distribution of load over the transmission system.

The loss of only 10 per cent. in efficiency is evidence of the distribution at relatively high pressure over relatively short distances.

Fig. 4 also shows the growth of the maximum sustained load and of the total output of the system since January 1st, 1911. The maximum sustained load means the maximum number of units sent out from all generating stations during the successive hours of the month, or, in other words, the maximum hourly average load.

This now exceeds 90,000 KW., and including the compressor supply at Robinson Central reaches well over 100,000 KW.

An interesting comparison can be drawn between the power companies' business and that of the Chicago, New York, Johannesburg and Randfontein systems, for which fig. 6 shows the smoothed load curves for a single week-day, prorated to that of the power company.

In this the curve for each scheme is proportioned up or down, so that it may have the same summit as the power companies' curve. It will be seen that the load factor of the latter is higher than that of either of the three systems which supply a miscellaneous collection of different types of consumers, whilst the load factor at Randfontein is higher than that of the power companies' system.

The Randfontein curve is, however, not strictly representative as abnormal conditions prevailed at the time. The week-

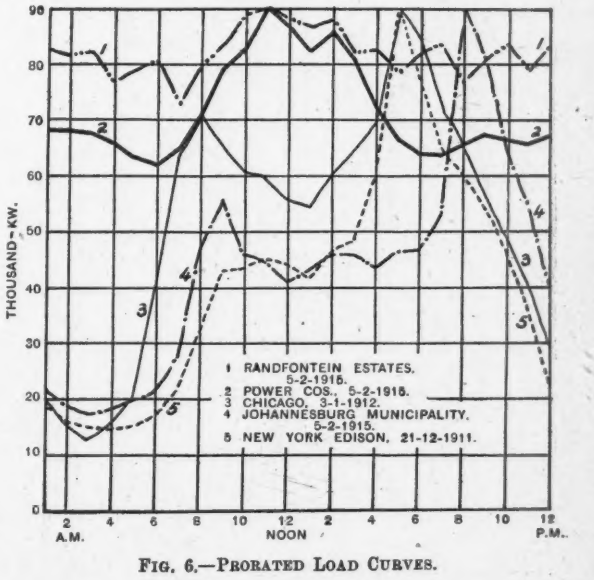


FIG. 6.—PRORATED LOAD CURVES.

day load factors calculated from these curves are approximately as follows:—Chicago, 56; New York, 44; Johannesburg, 47.5; Power Companies, 79.5; Randfontein, 91.5. The period of duration of the upper portion of the peak on the power companies' curve, namely, from 9 a.m. to 3 p.m., does not overlap the peak of any of the other curves excepting that of the neighbouring system at Randfontein, which latter also deals solely with supply to the gold mining industry.

Taking first the New York Edison curve, it will be observed that this is typical of power and lighting supply to a large city; the Johannesburg curve is similar in shape, except that there is a minor traction peak in the morning, and the evening peak occurs at a different time, it being a summer day in

Africa and a winter day in America. The Chicago curve shows clearly the benefit which that concern is securing from a railway load. The morning peak is more pronounced, and the average load during the day is a large proportion of the evening peak. The Randfontein curve shows the same period of peak as the power companies' curve, but flatter.

The characteristics of the power companies' load may be compared with that of, say, Chicago on another basis, namely, by taking the number of hours of use of various percentages of the full amount of plant in service during the peak.

These curves, which may be termed "load duration curves," are shown in fig. 7.

It will be observed that the power companies use 90 per cent. of the peak capacity of plant for 1,000 hours per annum, as against less than 100 hours for Chicago, and that 50 per cent. of the plant is used for about 8,400 hours and 2,700 hours respectively.

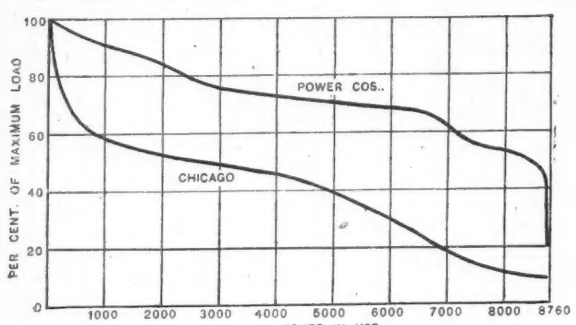


FIG. 7.—LOAD DURATION CURVES.

It will be clear from these comparisons that conditions here on the Witwatersrand are unique. The present method of operating the mines results in a load curve having a peak of considerable duration, but this peak occurs at an unusual time, and would not overlap the peaks on the curves of a traction or a city lighting and power supply if these latter were added to the power companies' system. As engineers, we desire to get the best possible results out of our work; as business men, we want to supply the greatest possible amount of service at the lowest possible cost to the consumer, and the greatest possible profit to our own particular concern; but whether we be engineers or business men, or both, we all desire to avoid unnecessary waste of capital and the world's' resources. Mr. Ferranti, when addressing the Home Institution in 1910, boldly outlined a scheme for the generation and distribution of electric power for the whole of Great Britain, and showed the enormous saving in capital and in fuel which would result if electricity were to become the universal medium for supplying all heating, lighting, and power requirements. I, personally, believe that some day this vision will materialise in a broad form, if not in detail, and that even in the more sparsely populated continent of Africa the conservation of the country's resources by the aid of electric power will be deemed to be matters of national import. The difficulty is that changes of this order can only mature gradually, and small advances do not permit the large economies which would be secured if it were possible for the ideal scheme to be laid out from the beginning. There is, nevertheless, a vast field for conservation within immediate grasp. The power problem in London is an outstanding instance, and it is gratifying to see that there is at least some prospect of a combination of interests in that important field. America is already leading the way, as witness the rapid development of the Chicago Edison Co. during recent years. The strong position to which that vast concern has attained and the resulting benefits to consumers is the outcome of the concentration of various types of supply in one large system, under the enterprising and far-sighted guidance of Mr. Samuel Insull. Here on the Rand, it may be said that the field is a relatively restricted one, but its possibilities have not yet been exhausted. The eastern portion of the Rand promises well, and it is reasonable to hope that a further extension of this vast gold-bearing area will some day be discovered.

NEW PATENTS APPLIED FOR, 1915.

(NOT YET PUBLISHED).

Compiled expressly for this Journal by MESSRS. W. P. THOMPSON & Co., Electrical Patent Agents, 285, High Holborn, London, W.C., and at Liverpool and Bradford.

10,785. "Rumblers and the like for electrolytic purposes." C. J. LANE and D. L. HONEYMAN. July 26th. (Complete.)

10,803. "Vacuum drying and impregnating device, more especially suitable for treatment of the coils of electrical machinery and apparatus." E. HAEFELY & Co., AKT. GES. July 26th. (Convention date, July 24th, 1914, Switzerland.) (Complete.)

10,837. "Flexible electric conductors." A. J. DOWNES. July 26th.

10,845. "Electric ignition devices." A. L. KAVANAGH. July 27th.

10,851. "Joint or intersection boxes and means for connecting electric cables thereto." J. COATES & G. J. JONES. July 27th.

10,901. "Manufacture of electric apparatus." M. SEGRE. July 27th, (Complete.)

10,938. "Electric switch controlling devices." A. W. HOUSE. July 28th.

10,957. "Electric railway systems." THE RT. HON. H. L. SAMUEL, W. SLINGO, H. C. GUNTON, & C. H. DOUGLAS. July 28th. (Addition to 14,984/14.) (Complete.)

10,958. "Electric railway systems." THE RT. HON. H. L. SAMUEL, W. SLINGO, H. C. GUNTON, W. H. POWELL, & J. R. KINGSTON. July 28th. (Addition to 15,539/14.) (Complete.)

10,959. "Electrical dry and wet heating pad and bandage and the like." W. E. SIDAY. July 28th.

11,011. "Process for electrolytically depositing a strongly adherent and malleable layer of tin on iron and other metallic surfaces." P. MARINO. July 29th. (Complete.)

11,013. "Electric switch plugs." A. E. RULE and FELD BROS. & Co., LTD. July 29th.

11,033. "Magnetos." M. A. CODD. July 29th. (Complete.)

11,050. "Perpetual magnetic power wheel." H. M. GLOYNE. July 30th.

11,072. "Identification of electric cables." B. J. KAT and CALLENDER'S CABLE & CONSTRUCTION CO., LTD. July 30th.

11,074. "Electrodes." BRITISH THOMSON-HOUSTON CO., LTD. (General Electric Co., United States.) (July 30th.)

11,088. "Process and apparatus for the separation of suspended bodies from electrical insulating fluids, more particularly gaseous fluid." E. MOLLER. July 30th. (Convention date, July 31st, 1914, Germany.) (Complete.)

11,123. "Sparking-plugs and the manufacture of the same." T. CROSSBEE AND SONS, LTD., and W. J. SPICER. July 31st.

11,139. "Switch device for car-light and like dynamos." ALBION MOTOR CAR CO., LTD., and B. MURRAY. July 31st. (Complete.)

11,144. "Electric heaters." IGRANIC ELECTRIC CO., LTD. (Cutler-Hammer Manufacturing Co., United States). July 31st. (Complete.)

11,157. "Wireless telegraphy." J. LONGMAN. July 31st.

11,158. "Telephonic receiving apparatus." J. LONGMAN. July 31st.

PUBLISHED SPECIFICATIONS.

1913.

27,059. METHOD OF AND APPARATUS FOR SEPARATING DUST PARTICLES FROM GASES OR AIR BY MEANS OF HIGH-TENSION CURRENT. G. A. Krause. November 24th. (November 25th, 1912.)

27,060. METHOD OF SEPARATING SUSPENDED PARTICLES FROM GASES BY MEANS OF HIGH-TENSION ELECTRICITY. G. A. Krause. November 24th. (November 25th, 1912.)

27,157. SUPPORTS FOR ELECTRIC INCANDESCENT LAMP FILAMENTS AND THE MATERIAL FOR THE SAME. G. Ludecke and Brimsdown Lamp Works, Ltd. November 25th.

27,426. ELECTRIC VACUUM-LIGHT APPARATUS. Moore-Licht Akt. Ges. November 28th. (November 28th, 1912. Addition to 1,218/13.)

27,473. AMPERE METER AND VOLT METER FOR VEHICLES AND THE LIKE. Schoeller & Co. November 28th. (February 10th, 1913.)

27,515. CONTROL OF ELECTRO-MECHANICAL SWITCHES FOR TELEPHONE EXCHANGES. H. Baron (F. Aldendorff). November 29th.

27,590. CRAMP BELTS ADAPTABLE AS ELECTRODE CONTACT CRAMPS AND HOLDERS AND FOR OTHER PURPOSES. J. S. Romanes. December 1st.

28,291. ELECTRO-MECHANICAL SWITCHING SYSTEMS FOR INTERCONNECTING TELEPHONE LINES. H. Baron (F. Aldendorff). December 8th.

28,362. SWITCHING SYSTEMS AND APPARATUS FOR INTERCONNECTING TELEPHONE LINES. F. Aldendorff. December 9th.

28,502. SWITCHING APPARATUS FOR INTERCONNECTING TELEPHONE LINES BY ELECTRO-MECHANICALLY-CONTROLLED SWITCHES. F. Aldendorff. December 10th.

28,833. METHOD OF INTERCONNECTING LINES BY ELECTRO-MECHANICALLY-CONTROLLED SWITCHES. H. Baron (F. Aldendorff). December 13th.

29,946. TRANSMITTING ARRANGEMENTS FOR HIGH-FREQUENCY WIRELESS TELEGRAPHY AND TELEPHONY. G. G. Con Arco & A. Meissner. December 30th.

1914.

284. ANODE OF HARD-LEAD FOR ELECTROLYTICAL PURPOSES. E. C. R. Marks (Siemens & Halske Akt. Ges). January 5th.

299. DEVICES FOR BRAKING ALTERNATING-CURRENT COMMUTATOR MOTORS. Siemens Schuckertwerke Ges. January 5th. (January 4th, 1913.)

450. SEMI-AUTOMATIC OR AUTOMATIC GRADED SERVICE TELEPHONE SYSTEMS. H. Baron (G. Heimann). January 7th. (Addition to 11,888/13.)

452. TRANSMITTER FOR DISTANT CONTROLLING-APPARATUS FOR ORDNANCE. R. Girardelli. January 7th. (Convention date not granted.)

459. NUMBER IMPULSE INSTRUMENT FOR AUTOMATIC OF SEM-AUTOMATIC TELEPHONE SYSTEMS. Siemens & Halske Akt. Ges. January 7th. (April 17th, 1913.)

742. ELECTRODE FURNACES WHICH HAVE AN ARRANGEMENT FOR AUTOMATICALLY MIXING UP THE CHARGE. Fried Krupp Akt. Ges. January 10th. (January 17th, 1913.)

828. THERMOSTATIC REGULATING DEVICES. W. C. Heraeus Ges. January 12th. (January 29th, 1913.)

900. SELF-LOCKING ELECTRIC LAMPHOLDER. F. Cacha. January 13th.

963. ELECTRICALLY-DRIVEN VEHICLES. K. Von Kando. January 13th.

3,318. TROLLEY HEAD FOR ELECTRIC TRAMCARS, LOCOMOTIVES, ROPE RAILWAYS, AND THE LIKE. L. Johnston & G. W. Green. February 9th.

9,289. CONTROLLING SWITCHES FOR ELECTRICALLY-ACTUATED LIFTS. G. Dirks. April 14th. (April 14th, 1913.)

9,444. SPARKING PLUGS OR IGNITERS FOR INTERNAL-COMBUSTION ENGINES. P. H. Tismer. April 16th. (October 16th, 1912. Divided application on 23,185/13, October 14th.)

13,933. ELECTRIC CABLES AND CABLE SYSTEMS AND JOINTS FOR USE THEREIN. E. G. Walters and Callender's Cable & Construction Co., Ltd. June 9th, (Cognate application, 14,946/14.)

14,294. ELECTRIC CONTROLLERS. A. West. June 15th.

16,111. GLOVES FOR PREVENTING ELECTRIC SHOCKS. J. G. Conway. July 6th.

16,149. HOLDERS FOR ELECTRIC INCANDESCENT LAMPS. F. Smith & T. J. Loach. July 7th.

16,411. AUTOMATIC TELEPHONE SYSTEMS. Relay Automatic Telephone Co. (formerly known as Betulander Automatic Telephone Co., Ltd.), G. H. Bryant and F. M. Ward. July 9th.

16,583. APPARATUS FOR ELECTRICALLY TRANSMITTING PATTERNS AND PICTURES IN TEXTILE MACHINES. Osterreichische Siemens Schuckertwerke and Regal Patente Ges. July 11th. (July 12th, 1913.)

16,595. ELECTRIC ALARMS. J. Banneyer. July 11th.

16,869. ELECTRIC METERS. British Thomson-Houston Co., Ltd. (General Electric Co., United States). July 15th.

16,986. COOLING OF DYNAMO-ELECTRIC MACHINERY. Hon. Sir C. A. Parsons. July 17th.

17,037. SYSTEM FOR THE OPERATION OF ELECTRIC WINDING MOTORS AND THE LIKE. S. H. Eckmann. July 17th.

17,089. PROCESS AND APPARATUS FOR THE ELECTROLYSIS OF HALOGEN ALKALIES. Siemens & Halske Akt. Ges. July 18th. (July 26th, 1913. Addition to 18,102/13.)